

COST STUDIES OF MULTIPURPOSE LARGE LAUNCH VEHICLES

VOLUME V
BOOK A

BASELINE MLLV COSTS
GET READY OR "A" COSTS



FINAL REPORT

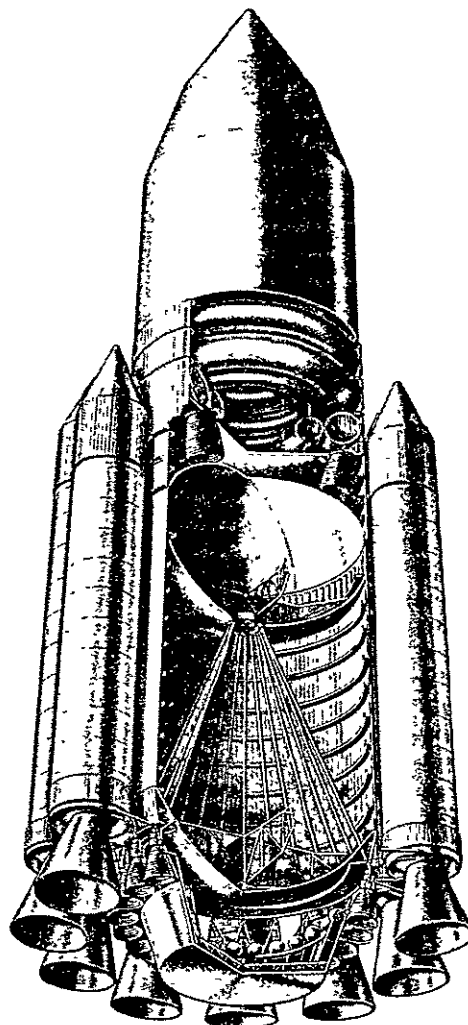
SEPTEMBER 15, 1969

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NASA DOCUMENT NO.

CR-73332-A

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PREPARED UNDER CONTRACT
NAS 2-5056

BY THE **BOEING** COMPANY
AEROSPACE GROUP
SOUTHEAST DIVISION

(BOEING DOCUMENT NO.
D5-13463-5)

N70-11126 **N70-11129**
(ACCESSION NUMBER) (THRU)
1264
(PAGES) (CODE)
NASA CR-73332 **31**
(NASA CR OR TMX OR AD NUMBER) (CATEGORY)

FACILITY FORM 603

N70-11127

FINAL REPORT
FOR
COST STUDIES OF MULTIPURPOSE
LARGE LAUNCH VEHICLES

BASELINE MLLV COSTS

BOOK A OF VOLUME V

PREPARED UNDER CONTRACT NAS2-5056
FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY
MISSION ANALYSIS DIVISION
SEPTEMBER 15, 1969

PREPARED BY




C. A. PENDER
J. LEE
W. RICHARD

SUPERVISED BY



J. R. TURNEY

APPROVED BY



JOSEPH W. MONROE

THE BOEING COMPANY
SOUTHEAST DIVISION
HUNTSVILLE OPERATION
HUNTSVILLE, ALABAMA

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ABSTRACT

Nine volumes including this volume present the final report documentation outlining the accomplishments for the "Cost Studies of the Multipurpose Large Launch Vehicles" (MLLV), NASA/OART Contract NAS2-5056. This MLLV cost volume presents the detailed costs for implementation and operation of the elements of the Multipurpose Large Launch Vehicle family.

The MLLV family will consist of a single-stage-to-orbit configuration plus other configurations consisting of a main stage (as used for the single-stage-to-orbit configuration) with various quantities of 260 inch diameter solid rocket motor (SRM) strap-on stages and/or injection stage modules. The main stage will employ LOX/LH₂ propellant with either a multichamber/plug or toroidal/aerospike engine system. The single-stage-to-orbit configuration will have a payload capability of approximately 500,000 pounds to a 100 nautical mile earth orbit. With the addition of the strap-on SRM stages and/or LOX/LH₂ injection stage modules, this payload capability can be increased incrementally to as much as 1,850,000 pounds.

The contract consisted of four study phases. The Phase I activity was a detailed cost analysis of an Advanced Multipurpose Large Launch Vehicle (AMLLV) family as previously defined in NASA/OART Contract NAS2-4079. Costs for vehicle design, test, transportation, manufacture and launch were defined. Resource implications for the AMLLV configurations were determined to support the cost analysis.

The Phase II study activity consisted of the conceptual design and resource analysis of a smaller or half size Multipurpose Large Launch Vehicle (MLLV) family.

The Phase III activity consisted of a detailed cost analysis of the smaller Multipurpose Large Launch Vehicle configurations as defined in Phase II. Costs for vehicle design, test, transportation, manufacture and launch were determined.

The Phase IV activity assessed the results of the study including the implications on performance, resources and cost of vehicle size, program options, and vehicle configuration options. The study results provided data in sufficient depth to permit analysis of the cost/performance potential of the various options and/or advanced technologies.

ABSTRACT (Continued)

KEY WORDS

Advanced Multipurpose Large Launch Vehicles (AMLLV)

Half Size Multipurpose Large Launch Vehicles (MLLV)

Single-Stage-to-Orbit

Multichamber/Plug Engine System

Toroidal/Aerospike Engine System

260 Inch Solid Propellant Rocket Motor (SRM)

Orbital Injection Stage

Contract NAS2-4079

Contract NAS2-5056

Payload to 100 NM Orbit

Cost

Resources

Zero Stage Vehicles

Parallel Stage Vehicles

Main Stage Throttling

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FOREWORD

This volume, Baseline MLLV cost, is one of nine volumes documenting the results of a twelve month study program "Cost Studies of Multipurpose Large Launch Vehicles," NASA/OART Contract NAS2-5056. The objective of this study was to define cost, cost sensitivities, and cost/size sensitivities of potential future launch vehicles to aid in the guidance of current and future technology programs. The baseline vehicles utilized to make this assessment were:

- a. The Advanced Multipurpose Large Launch Vehicles (AMLLV) as defined under NASA/OART Contract NAS2-4079.
- b. The Multipurpose Large Launch Vehicles (MLLV) as defined under this contract and described in Document D5-13463-2, "Half Size Vehicle (MLLV) Conceptual Design."

The program documentation includes this "Baseline MLLV Cost Volume," Volume V plus a Summary Volume, a Design Volume, a Resources Volume, Cost Volumes, Cost Implications Volume, Advanced Technology Implications Volume, and Appendices Volumes. Individual designations for these volumes are as follows:

Volume I	Summary
Volume II	Half Size Vehicle (MLLV) Conceptual Design
Volume III	Resource Implications
Volume IV	Baseline AMLLV Costs
Volume V	Baseline MLLV Costs
Volume VI	Cost Implications of Vehicle Size, Technology Configurations, and Program Options
Volume VII	Advanced Technology Implications
Volume VIII	Flight Control and Separation, and Stress Analysis (Unclassified Appendices)
Volume IX	Propulsion Data and Trajectories (Classified Appendices)

FOREWORD (Continued)

Data on the 260 inch diameter solid propellant rocket motor were obtained from the Aerojet General Corporation. Data on the multichamber/plug propulsion system were obtained from the Pratt and Whitney Division of the United Aircraft Corporation and the Rocketdyne Division of the North American Rockwell Corporation. Data on the toroidal/aerospike propulsion system were obtained from the Rocketdyne Division of the North American Rockwell Corporation.

These propulsion data were obtained from the propulsion contractors at no cost to the contract. The material received encompassed not only the technical data, but resources, cost, schedules and advanced technology information. This support materially aided The Boeing Company in the preparation of a complete and meaningful study and is gratefully acknowledged.

The study was administered under the direction of NASA/OART Mission Analysis Division, Ames Research Center, Moffett Field, California under the direction of the technical monitor, Mr. Edward W. Gomersall.

1.0 INTRODUCTION AND SUMMARY

This Volume V, Baseline MLLV costs, is the fifth of nine volumes reporting the results of the Contract "Cost Studies of Multipurpose Large Launch Vehicles." Contained in this volume are the results of the detailed cost analysis of the Multipurpose Large Launch Vehicle (MLLV) baseline vehicle family. This cost analysis constitutes Phase III, Task 1 of the study program. Included in this task, are the non-recurring and recurring costs for implementation and launch of the baseline (MLLV) vehicle family.

Figure 1.0.0.0-1 displays the manner in which the costs are categorized. The non-recurring costs are divided into two classifications; (1) "Get Ready Costs" or A costs, which are identified as the costs associated with getting ready to produce and operate the first production article (e.g., basic design, brick and mortar facilities, tooling, fabrication and erection, etc.) and (2) "R&D Costs" or B costs which are defined as all costs associated with the developmental testing of hardware items (e.g., static test, dynamic test, flight test, etc.). The recurring costs are identified as the "first unit" or C costs, which are defined as all the costs associated with the production and launch of the first flight vehicle.

The resource data were received from the effected working organizations in terms of required manhours, materials, tooling, equipment and facilities. Figure 1.0.0.0-2 displays these working organizations, their location relationships and the type of input data submitted. This data was developed into cost information by the addition of direct and overhead labor rates and factored items. Direct cost increments were sequentially totalled with factored indirect supporting costs. (Indirect and supporting costs include costs for quality control, program management, planning, training, structures and other program associated elements overhead and/or burdened costs and G&A). This data was then subjected to a thorough review prior to inclusion in this document to insure completeness, clarity and accuracy.

The depth of the cost reporting levels and supporting information necessitated that this cost volume be divided into three books. This book (Book A) contains the (Section 1.0) Introduction and Summary, (Section 2.0) Ground Rules and Assumptions, and (Section 3.0) Get Ready or A Costs. The second book (Book B) contains the (Section 4.0) Development Testing or B Costs. The remaining book (Book C) contains the (Section 5.0) First Unit or C Costs. Figure 1.0.0.0-3 shows the relationship of the three books described above to their proper section of the Volume V documentation. Further, each of the sections is subdivided into the areas of index, introduction, single stage vehicle costs, etc., as shown in the right hand portion on this figure. Each of the Book A through C costs are subdivided in the same manner to facilitate understanding of the method of reporting the cost data and to provide comparable cost elements.

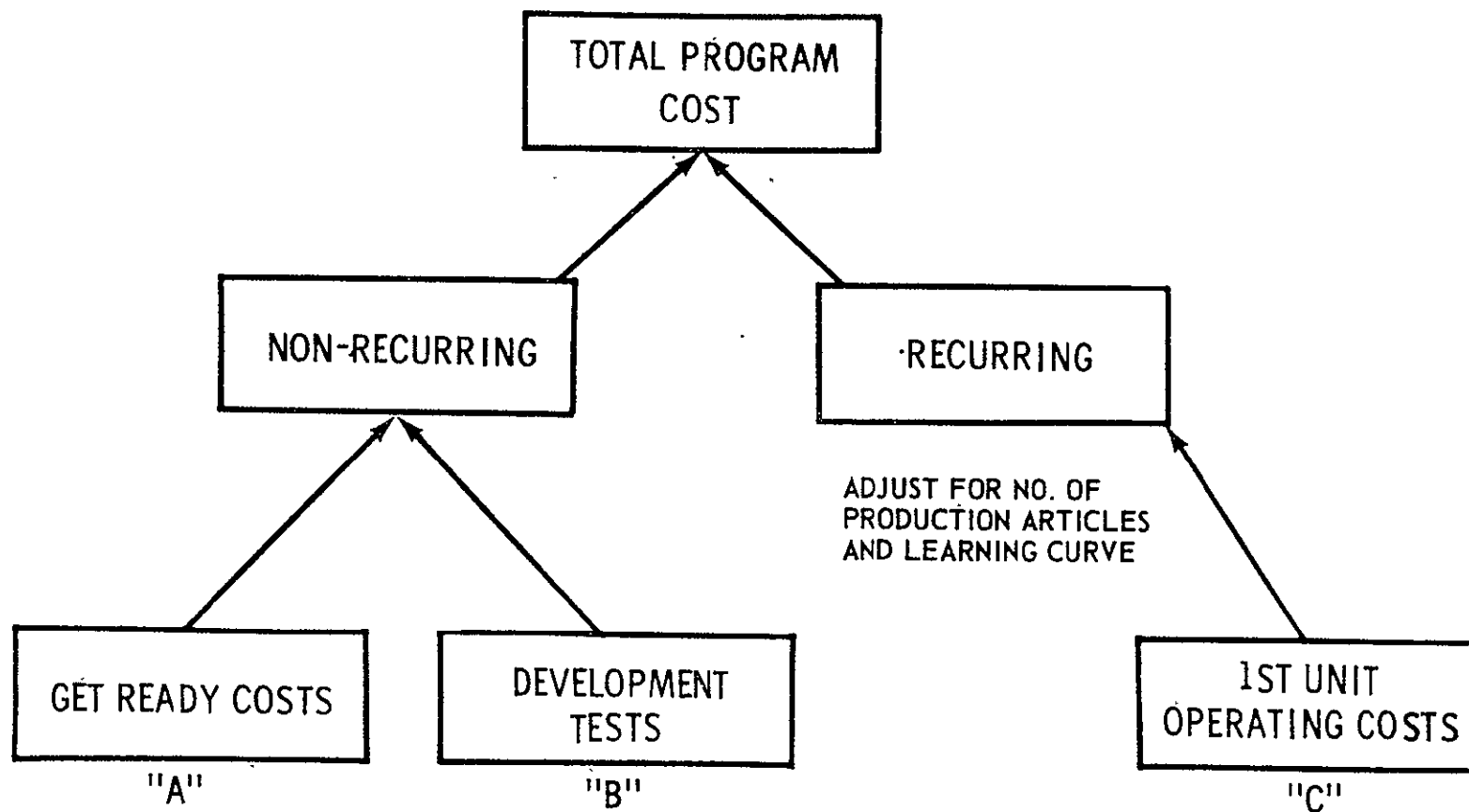


FIGURE 1.0.0.0-1 METHOD OF COST CATEGORIZATION

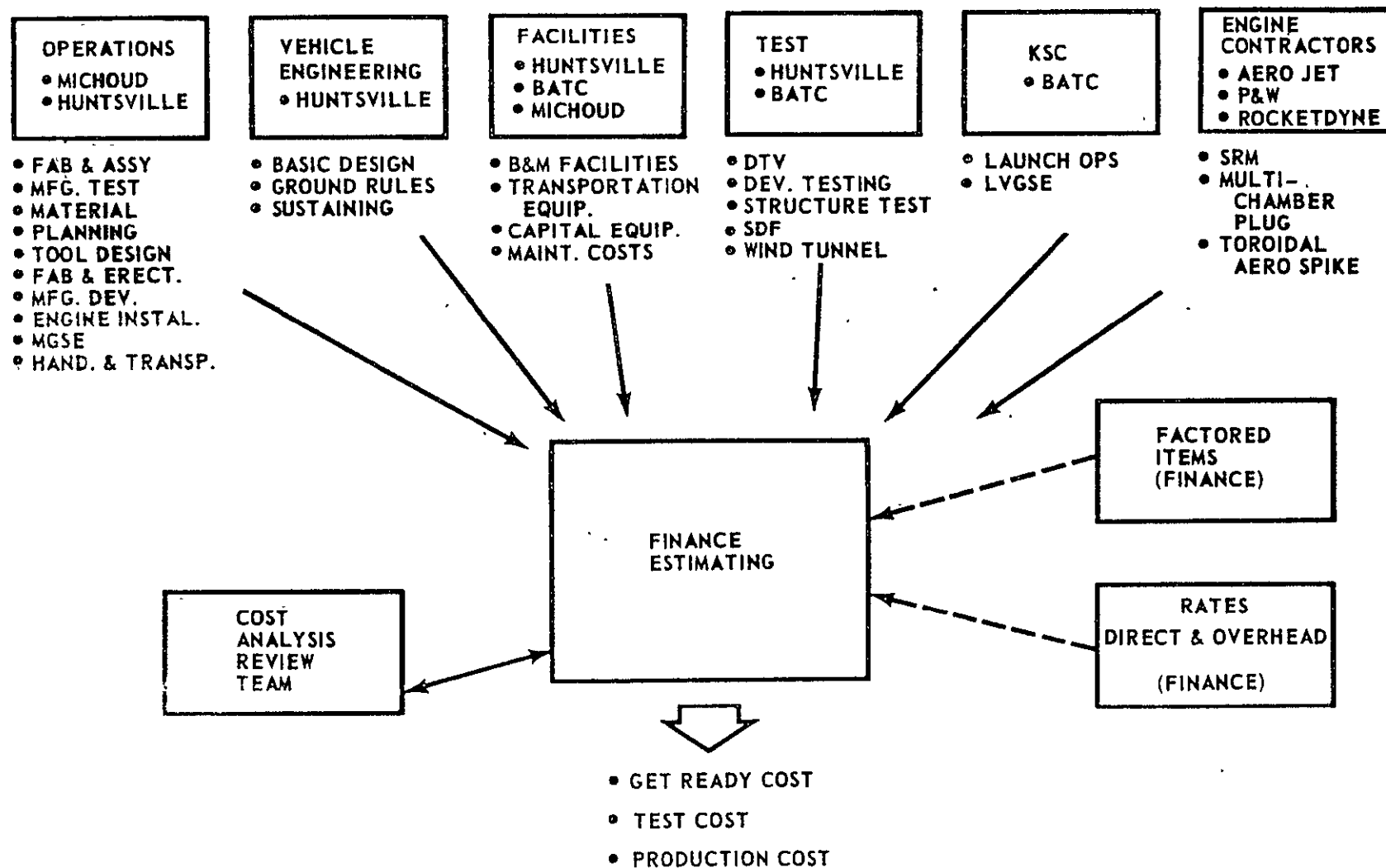
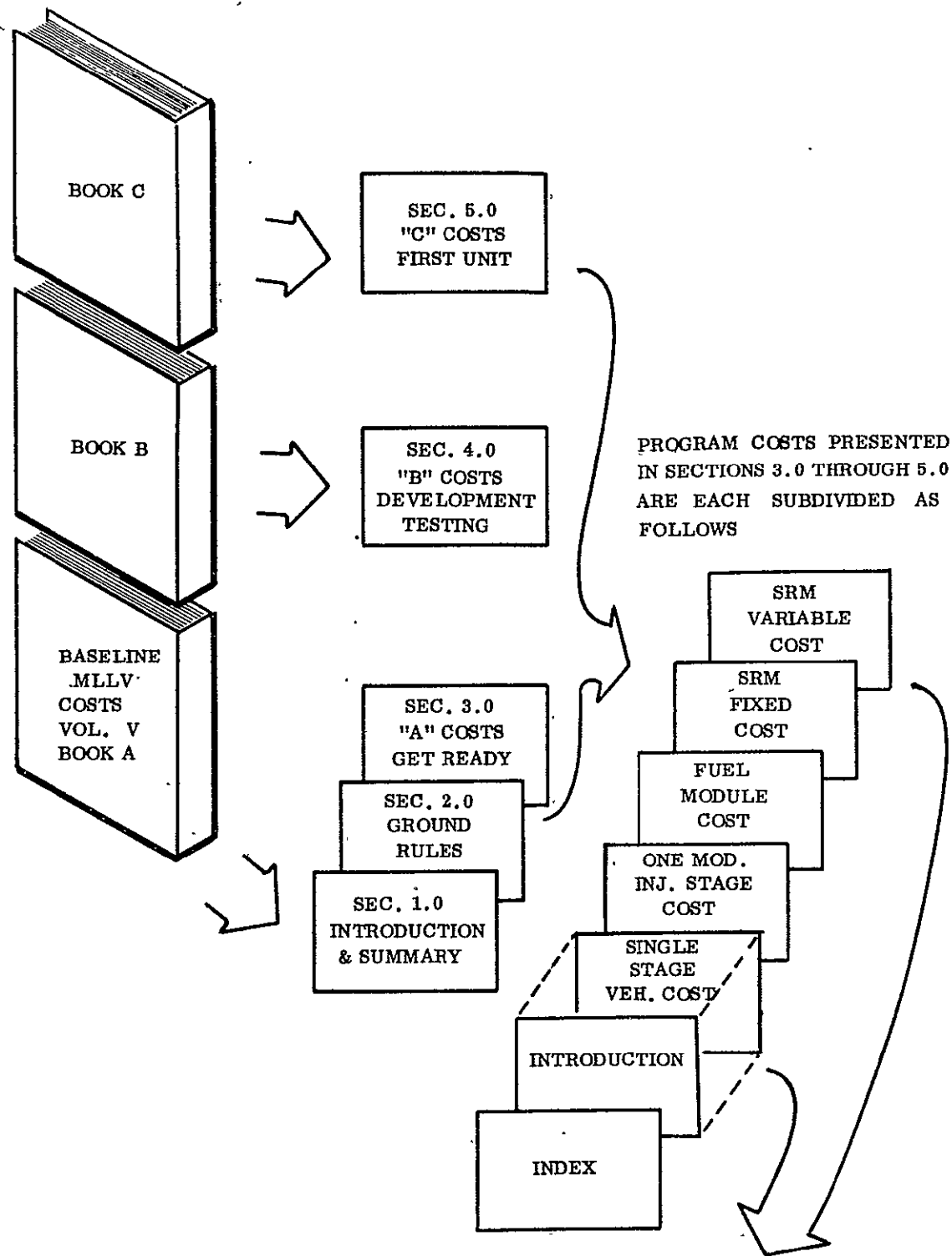


FIGURE 1.0.0.0-2 COST COLLECTION, TABULATION, AND ESTIMATING FLOW DIAGRAM



NOTE:

THE SECTION FOR EACH VEHICLE COMPONENT HAS A FLOW DIAGRAM THAT DISPLAYS THE DEPTH, COST AND LOCATION OF ALL APPROPRIATE DETAILS

FIGURE 1.0.0.0-3 REPORTING OUTLINE FOR VOLUME V, BASELINE MLLV COSTS

1.0 (Continued)

With the A, B, and C costs shown in these three books of Volume V, the total program costs for the selected baseline MLLV family are presented in a modular form which permit the determination of the cost of any desired phase, element or category of the baseline MLLV family cost. This is illustrated in Figure 1.0.0.0-4. With this detailed breakdown of costs, it is possible to determine what impact these costs have on total program costs or it is possible, through substitution, to insert revised or amended cost data in place of the existing data.

An example of how the cost data can be used is illustrated by the "PIE" charts contained on Figures 1.0.0.0-5 through 1.0.0.0-7 which display the "A", "B" and "C" costs by program element, for the MLLV single-stage-to-orbit vehicle. These charts give a clear graphic picture of each major element cost impact on the total program cost. For example, in Figure 1.0.0.0-7, the MLLV single-stage-to-orbit first unit cost by element is shown. The systems cost is 18.0 percent of the total vehicle cost. Further analysis of the systems cost is shown in the lower left hand pie chart. The propellant/mechanical systems are 59.1 percent of the systems cost. Examining this cost in more detail shows that its major cost element is the contract end-item, which is 95.4 percent of the total cost. The contract end-item is then divided into its cost by component as shown in the lower right hand pie chart. The major cost element is the material cost, 62.8 percent. The material cost of the vehicle system is, therefore, $62.8 \times 95.4 \times 59.1 = 35.4$ percent of the systems cost or 6.76 percent of the total vehicle cost. Similar comparisons of other elements will permit identification of their costs as a percentage of the total costs. With this data available, the desirability of a change (based on cost only) can be readily analyzed. High cost elements can be identified and emphasis can be placed upon these areas for further study.

Figure 1.0.0.0-8 through 1.0.0.0-10 display the "A", "B" and "C" costs by cost categories for the MLLV single stage to orbit vehicle. These charts display the costs by categories such as tooling, engineering, quality control, etc., rather than by elements. These charts can be used to determine where cost driving categories are and indicated areas where further study should be undertaken to reduce costs.

Figures 1.0.0.0-11 through 1.0.0.0-13 summarize the complete "A", "B" and "C" costs. These cost flow diagrams indicate the costs of components and/or operations related to the various vehicle stages and identify the applicable sections of this volume in which the detailed costs can be found. The "B" cost flow diagram is repeated in Book "B" and the "C" cost flow diagram is repeated in Book "C" to facilitate understanding of the method of presenting the cost data.

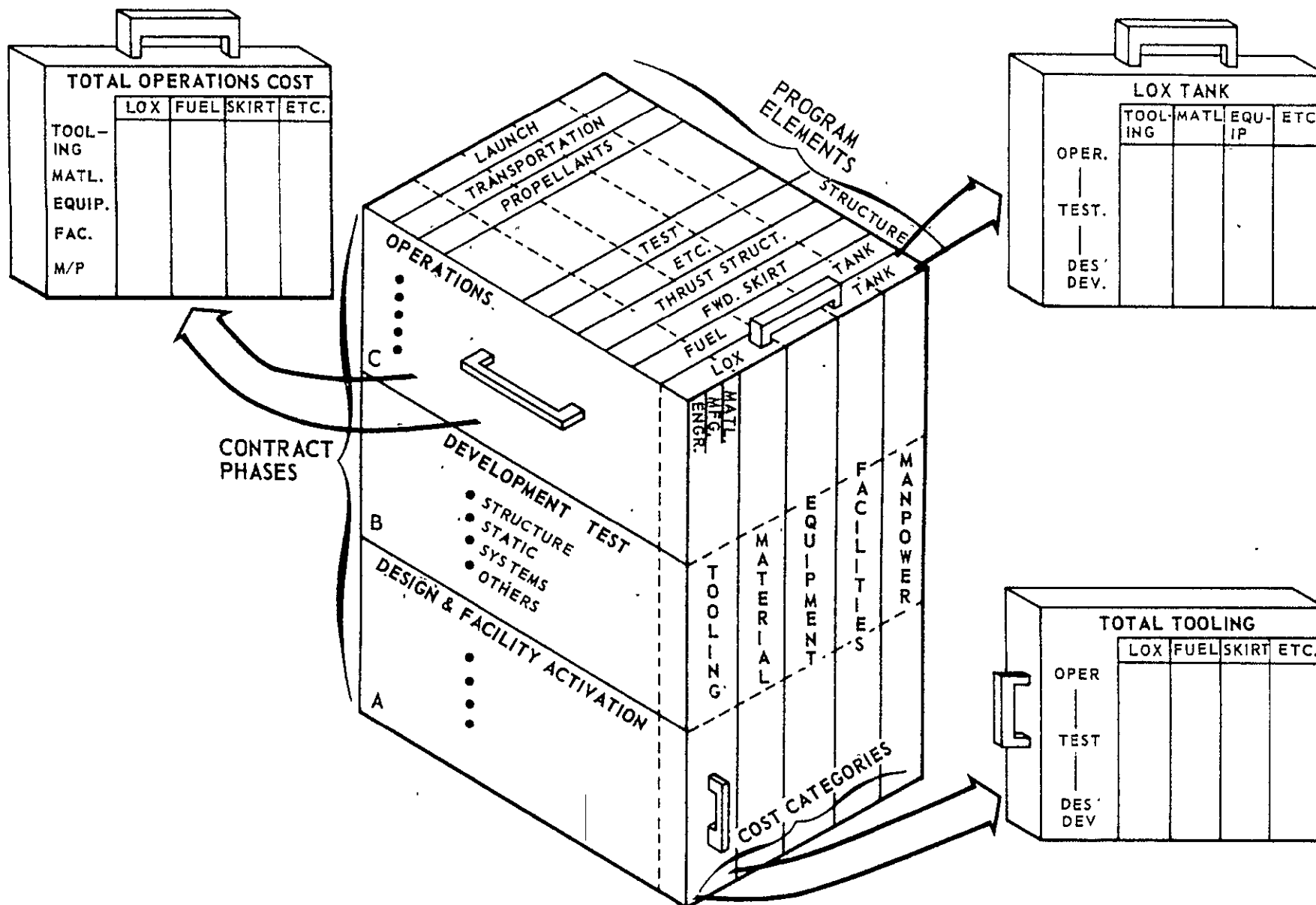


FIGURE 1.0.0.0-4 SCHEMATIC OF MODULAR COST DATA DEVELOPED FOR COST REPORTING

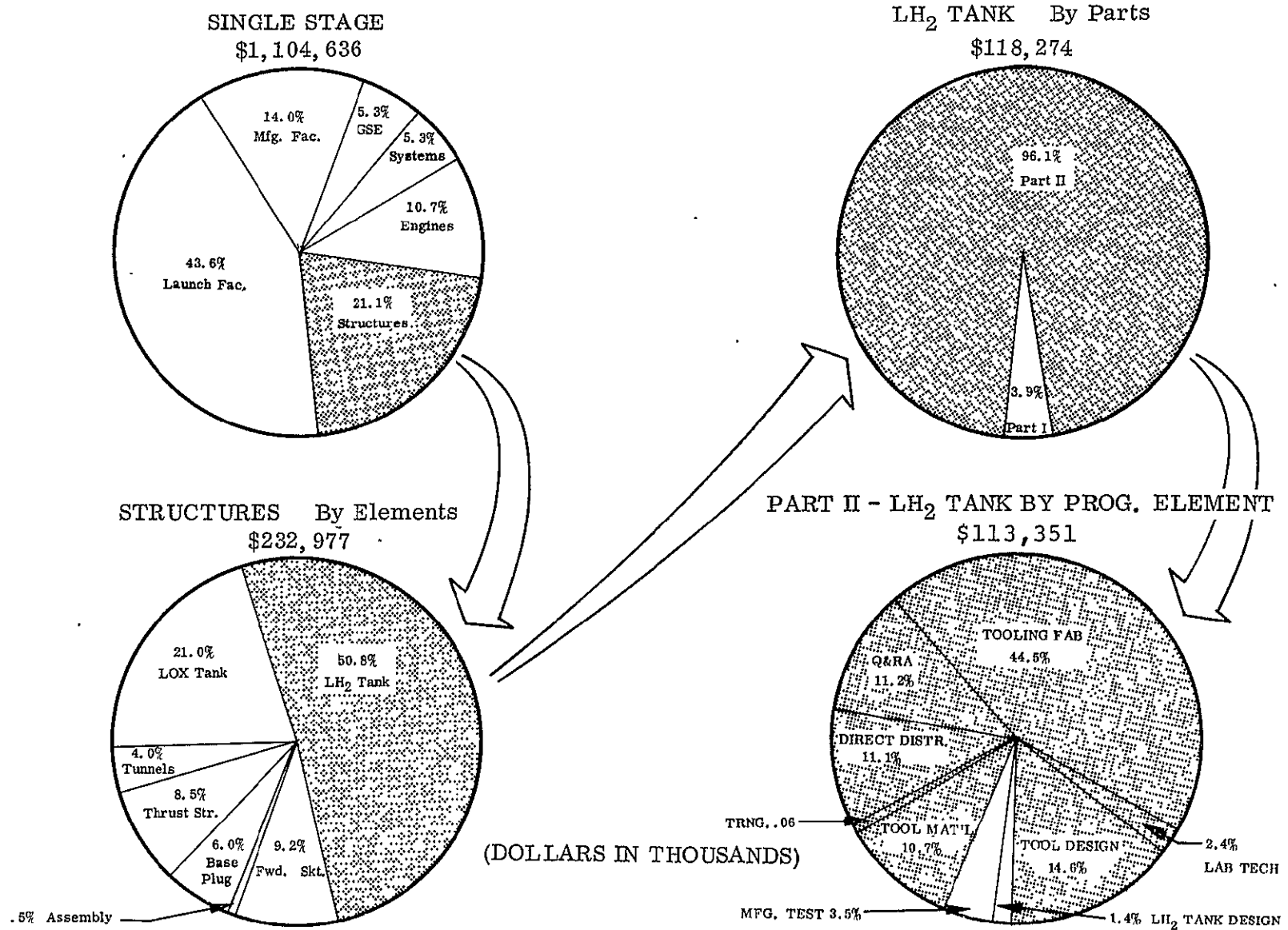


FIGURE 1.0.0.0-5 MLLV SINGLE STAGE VEHICLE GET READY OR "A" COST BY PROGRAM ELEMENT

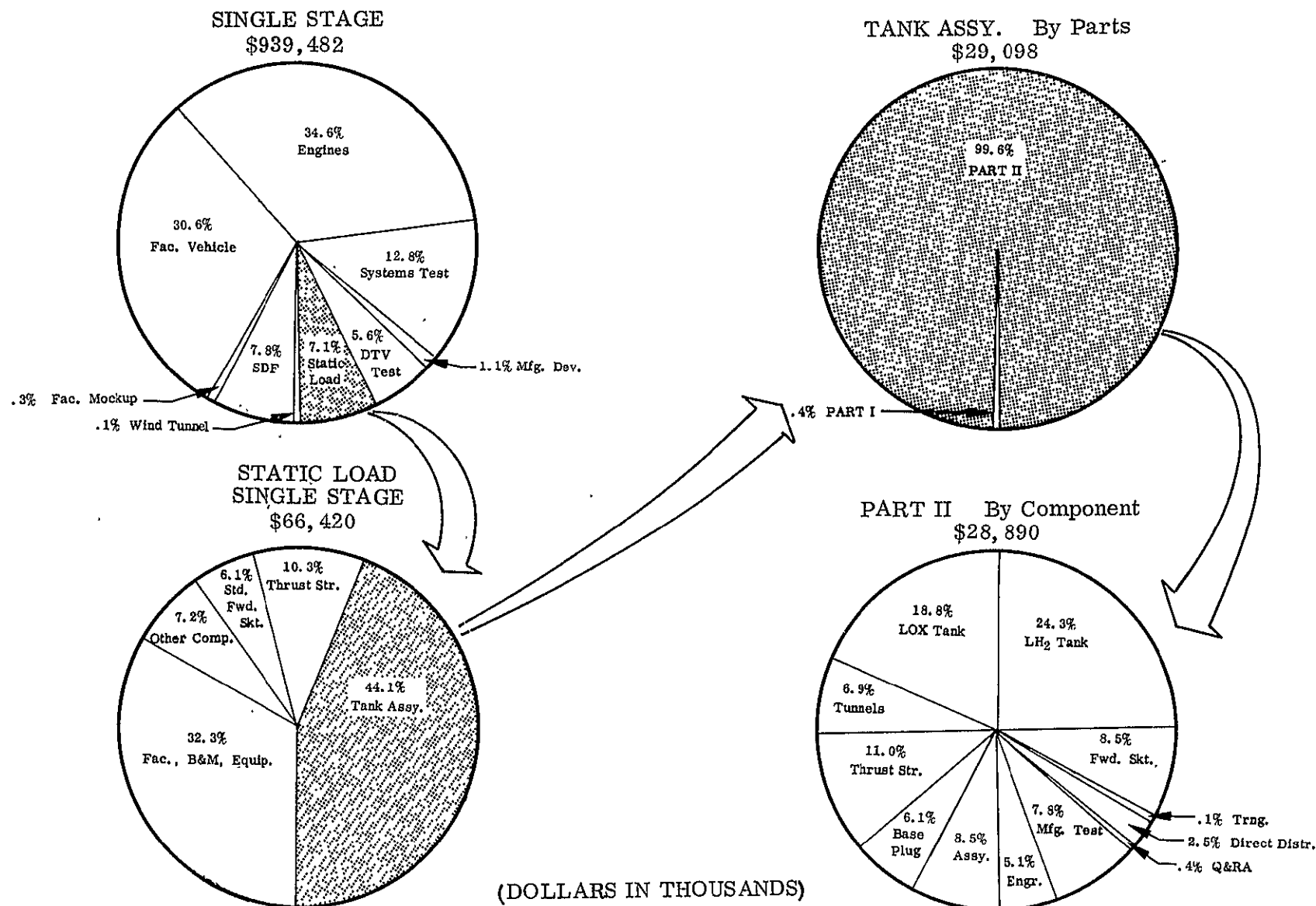


FIGURE 1.0.0.0-6 SINGLE STAGE VEHICLE DEVELOPMENTAL TEST OR "B" COST BY PROGRAM ELEMENT

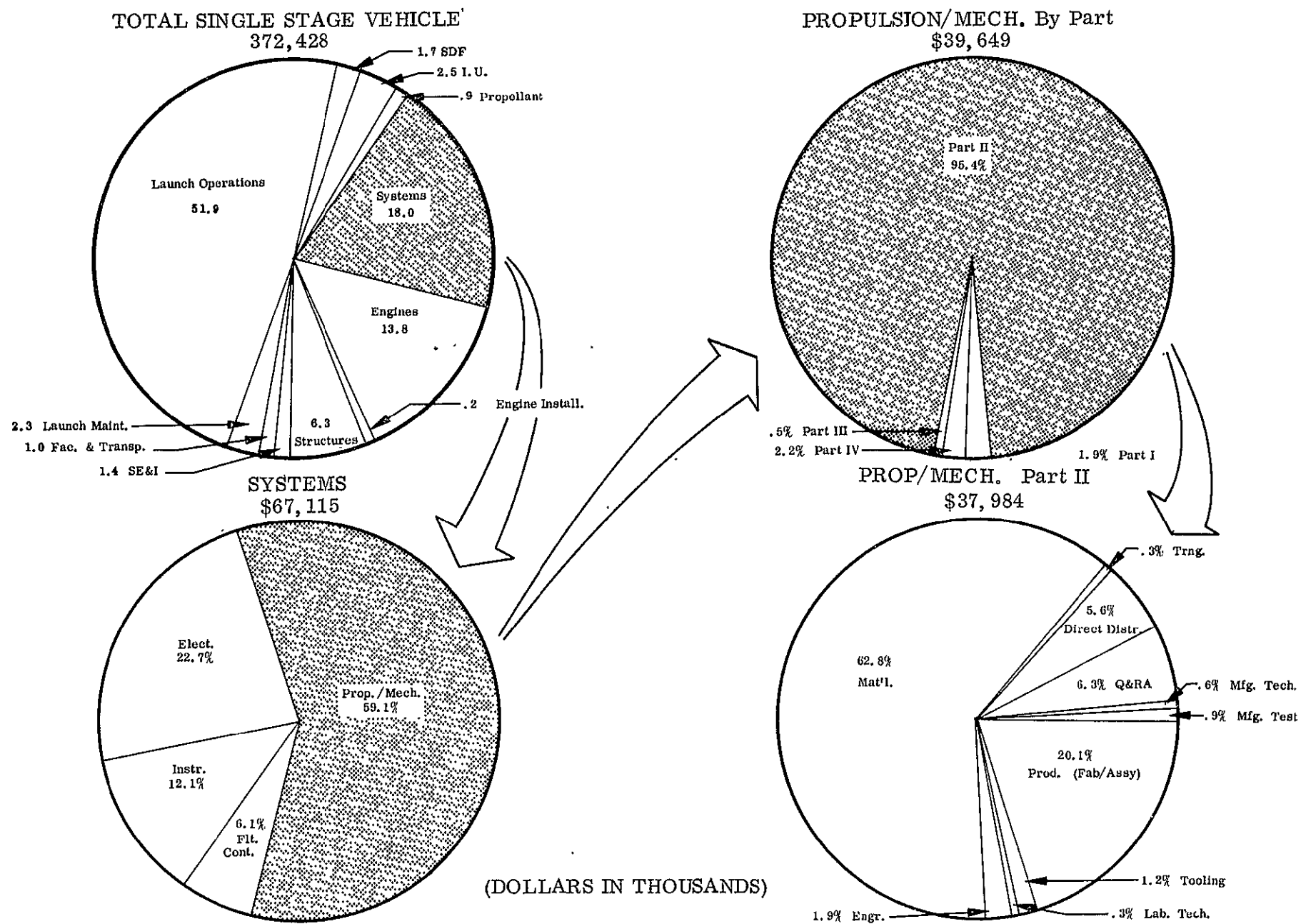
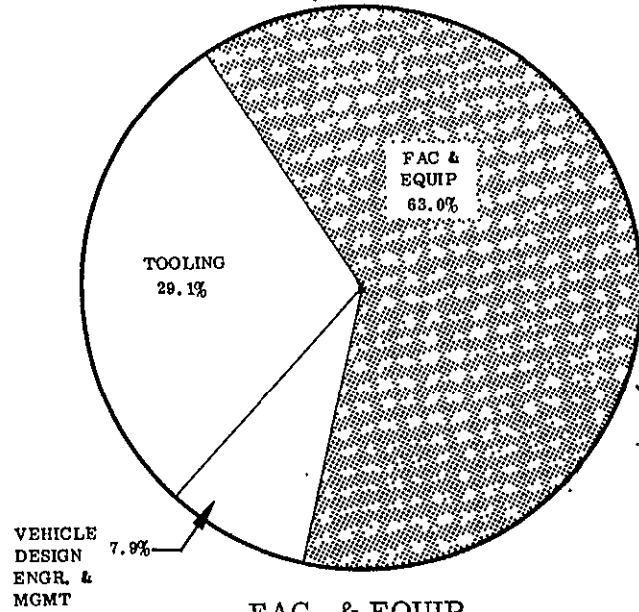
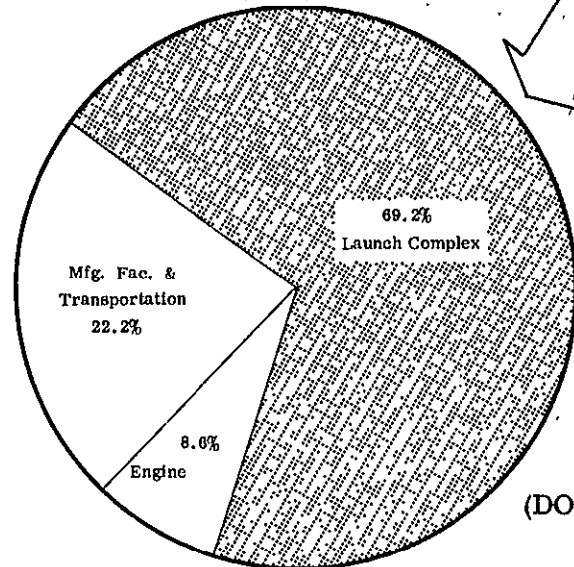


FIGURE 1.0.0.0-7 MLLV SINGLE STAGE VEHICLE FIRST UNIT (1ST R&D FLIGHT VEHICLE) OR "C" COST BY PROGRAM ELEMENT

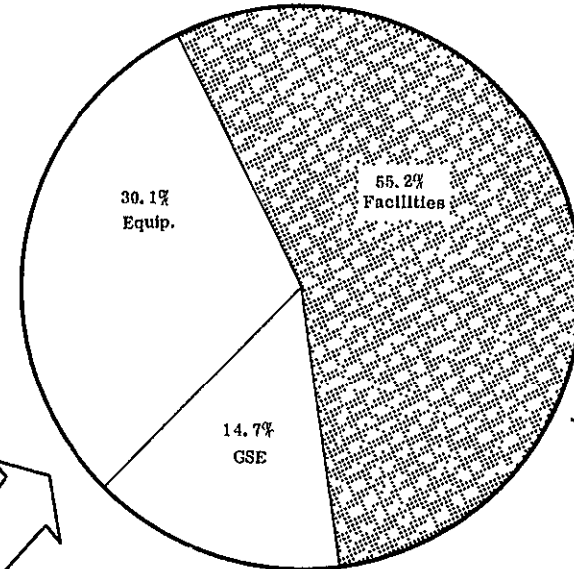
TOTAL SINGLE STAGE VEHICLE
\$1,104,636



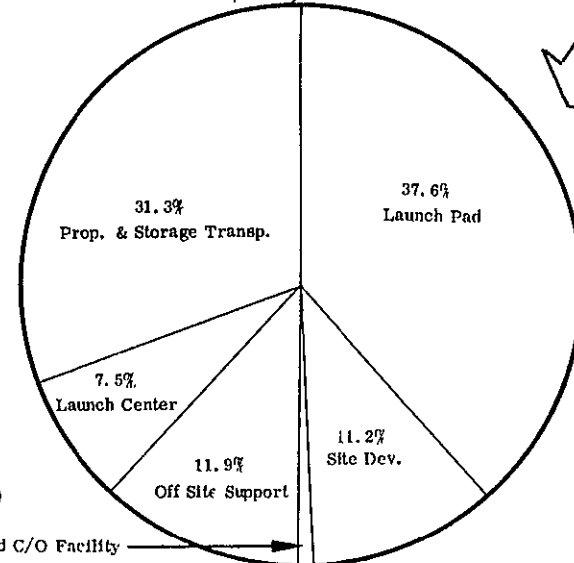
FAC. & EQUIP.
\$696,380



LAUNCH COMPLEX
\$481,547



LAUNCH COMPLEX FACILITIES
\$265,863



(DOLLARS IN THOUSANDS)

.5% Stage Storage, Test and C/O Facility

FIGURE 1.0.0.0-8 MLLV SINGLE STAGE VEHICLE GET READY COST BY COST CATEGORIES

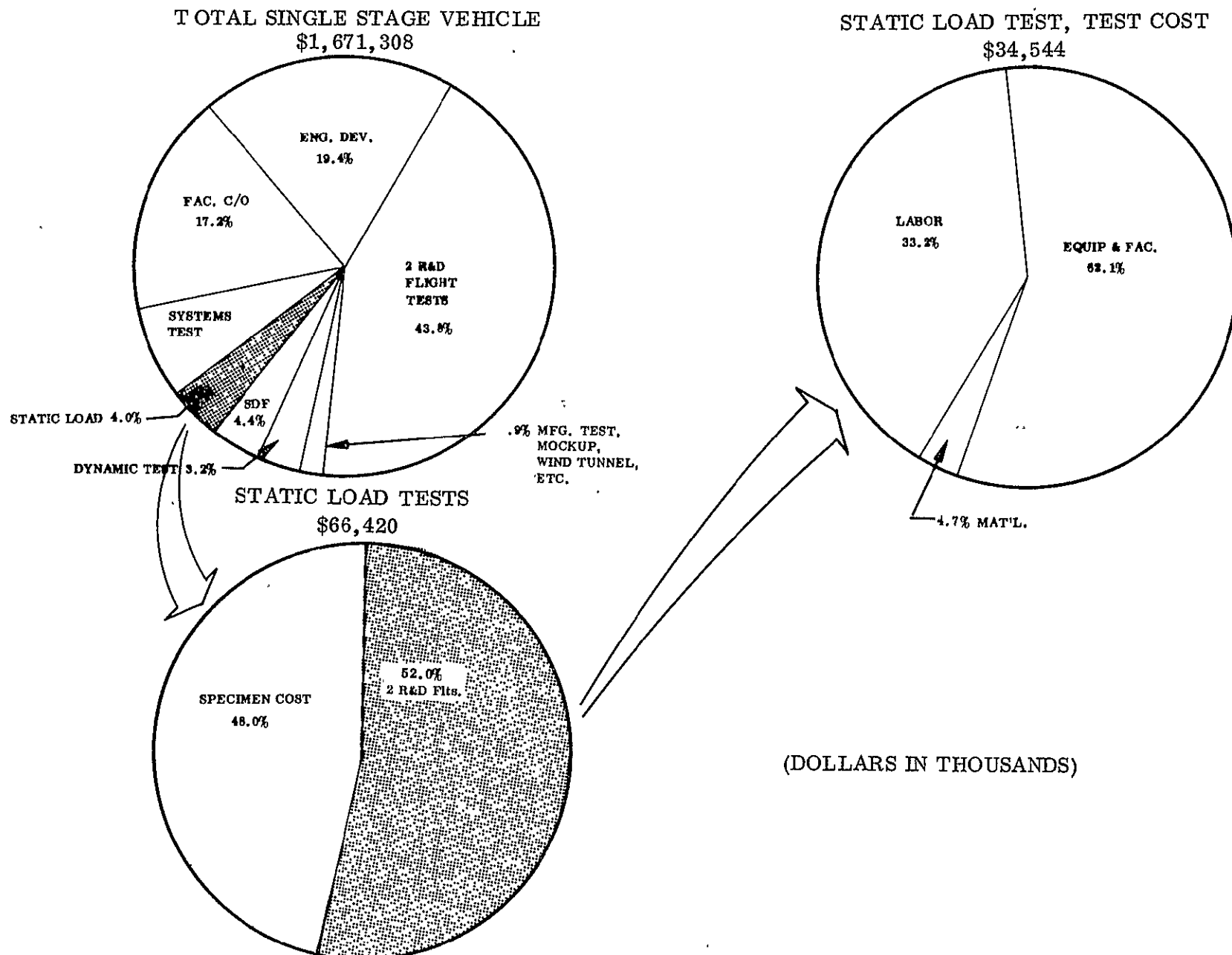


FIGURE 1.0.0.0-9 MLLV SINGLE STAGE VEHICLE DEVELOPMENT TEST COST BY COST CATEGORIES

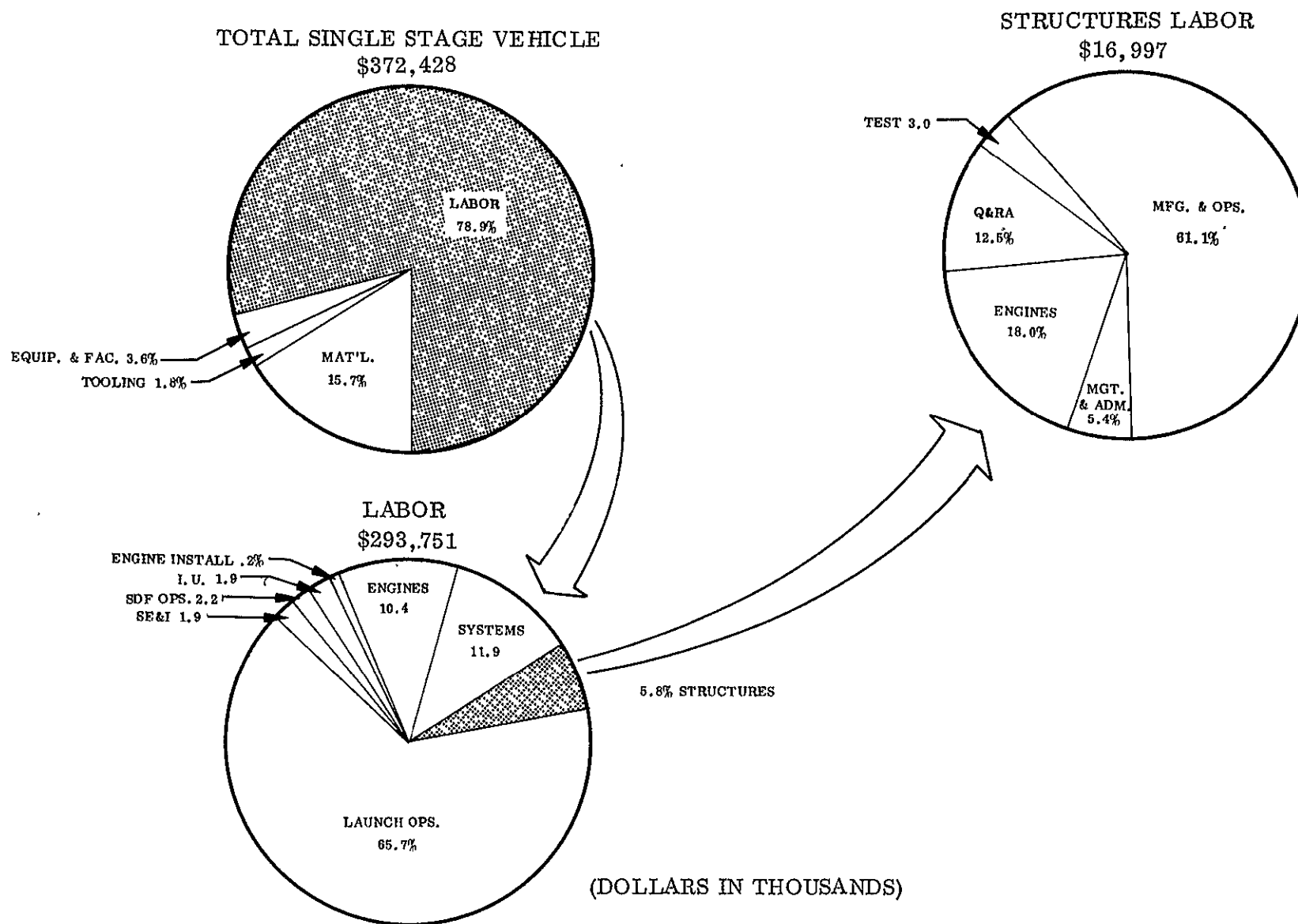
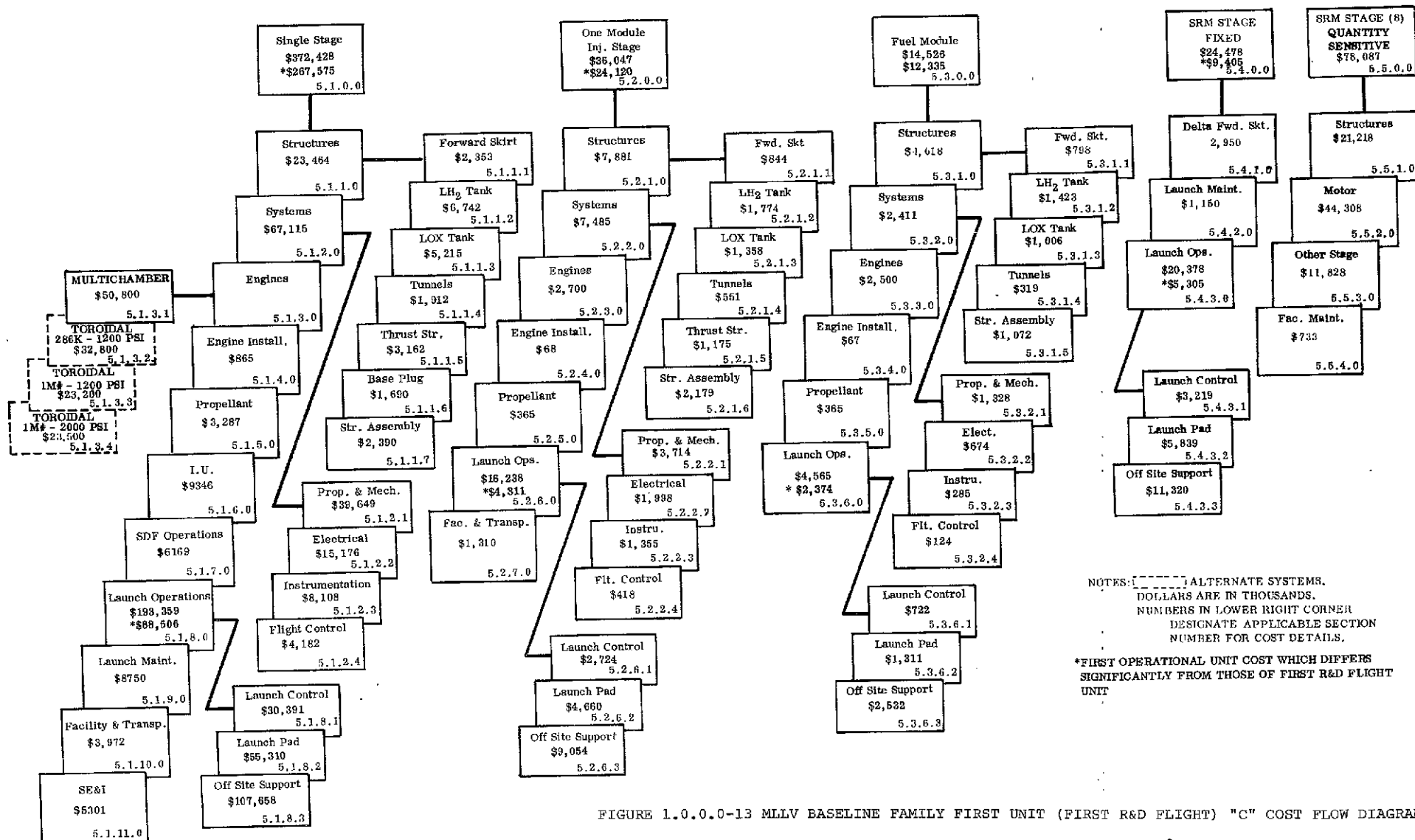


FIGURE 1.0.0.0-10 MLLV SINGLE STAGE VEHICLE FIRST UNIT COST BY COST CATEGORIES



NOTES: [] ALTERNATE SYSTEMS.
DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

*FIRST OPERATIONAL UNIT COST WHICH DIFFERS
SIGNIFICANTLY FROM THOSE OF FIRST R&D FLIGHT
UNIT

FIGURE 1.0.0.0-13 MLLV BASELINE FAMILY FIRST UNIT (FIRST R&D FLIGHT) "C" COST FLOW DIAGRAM

1.0 (Continued)

In addition to the cost distributions shown by program and/or stage elements, costs can be distributed by cost categories, i.e.: labor, material, tooling, facilities and equipment. Tables 1.0.0.0-I through 1.0.0.0-IX show such distributions for the single-stage-to-orbit vehicles, as three module injection stage and eight SRM strap-on stages respectively for each of the three program phases.

The distribution of costs to the cost categories was accomplished by reviewing each individual entry in the back-up detailed cost sheets in the AMLLV and MLLV baseline costs contained in Volumes IV and V, respectively. Assignment of a specific cost entry to a given cost category was based on an individual judgement of each entry. Some of these assignments required arbitrary assumptions which would effect the total distributions shown. For example, manpower and vehicle material as shown, relate only to that manpower and vehicle material to be expended to design, test, build and operate the vehicle. Manpower required in support of the other categories, i.e., tooling, material, facilities and equipment is included in the cost of those items as applicable. For example, manpower for tool design is shown as a tooling cost. Similarly, material required for tooling is shown as a tooling cost. Material costs as assigned to the vehicle material category reflect all costs for purchases material (inclusive of purchased assemblies and subsystems) to be used to design, test, manufacture and operate the vehicle. SRM and liquid engines for this distribution were not considered purchased assemblies (vehicle material) but were further broken down into the manpower, material, tooling, fabrication and equipment by categories. All systems and subsystems, on the other hand, were classified as vehicle material exclusively.

The distribution of Phase A costs by cost category indicates that a significant portion of the "Get Ready" costs will be attributable to Facilities and Equipment. The next largest cost category will be tooling.

The costs for vehicle material will be negligible. Program management and engineering design costs will represent approximately only 1.3 percent and 8.9 percent respectively of the total Phase A costs.

The distribution of costs by categories for Phase B include not only the costs for conducting the test, but also the costs required to provide the test specimens. The manpower costs will represent the major portion (70%) of the liquid stage B costs. As most of the SRM stage test components will be purchased, material costs for the SRM will exceed the manpower costs.

The distribution of costs by category for the first operational unit (C cost) shows that the costs for manpower will represent by far the majority of the liquid stage production and launch costs. Manpower costs will be a smaller percentage

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TABLE 1.0.0.0-I

MLLV - MAIN STAGE

DOLLARS IN THOUSANDS

COST ELEMENTS	LABOR		MAT'L	TOOLING				FAC. & EQUIP.	TOTAL
	Mgm't & Adm.	Vehicle Engr.	Misc.	Tooling Design	Tooling Mat'l	Mfg. & Set-Up	Tooling Q&RA		
STRUCTURES									
Fwd. Skirt	\$ 866	\$ 1,852	\$ 76	\$ 3,295	\$ 1,799	\$ 11,288	\$ 2,281	\$ -	\$ 21,457
LH ₂ Tank	4,923	1,483	60	19,374	10,403	68,617	13,414	-	118,274
LOX Tank	2,028	3,181	180	7,550	4,054	26,741	5,227	-	48,911
Tunnels	393	1,277	52	1,328	713	4,699	919	-	9,381
Thrust Structure	837	3,181	130	2,725	1,463	9,650	1,887	-	* 19,873
Base Plug	598	5,304	217	1,352	727	4,790	937	-	13,925
Assembly	51	1,061	44	-	-	-	-	-	1,156
Structures Total	9,696	17,339	709	35,624	19,159	125,785	24,665	-	232,977
SYSTEMS									
Prop./Mech.	1,319	5,304	218	4,235	2,274	14,998	2,933	-	31,281
Electrical	173	3,181	131	76	40	267	53	-	3,921
Instrumentation	442	8,485	347	104	55	368	72	-	9,873
Flight Control	158	1,699	70	307	166	1,088	212	-	3,700
Assembly	416	8,485	347	-	-	-	-	-	9,248
Systems Total	2,508	27,154	1,113	4,722	2,535	16,721	3,270	-	58,023
ENGINES	-	26,400	-	-	32,300	-	-	59,695	118,395
GSE	2,137	-	-	-	11,457	37,604	7,358	-	58,556
MFG. FACILITY	-	-	-	-	-	-	-	155,138	155,138
LAUNCH COMPLEX	-	-	-	-	-	-	-	481,547	* 481,547
MAIN STAGE TOTALS	\$14,341	\$70,893	\$1,822	\$40,346	\$65,451	\$180,110	\$35,293	\$696,380	\$1,104,636

*ALT. PAD 39 - \$122,400

"A" COST CATEGORIES

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TABLE 1.0.0.0-II

MLLV - MAIN STAGE

TYPE OF TEST	LABOR				MAT'L	TOOLING	EQUIP. & FAC.	SUB-TOTAL	TOTALS
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Q&RA					
STATIC LOAD TEST	\$ 494	\$ 3,477	\$ 7,218	\$ 269	\$ 1,634	\$ -	\$ 21,452	\$ 34,544	\$ -
Specimens	1,098	2,844	15,535	3,037	7,899	1,201	262	31,876	66,420
ENG. INSTALLATION TEST	2	-	35	7	8	-	-	52	-
Specimens	-	-	-	-	-	-	-	-	52
DYNAMIC TEST	520	3,496	6,539	1,225	1,915	-	15,945	29,640	-
Specimens	808	2,093	11,435	2,236	5,814	884	194	23,464	53,104
MANUFACTURING DEV.	357	-	6,571	1,314	1,681	-	-	9,923	-
Specimens	-	-	-	-	-	-	-	-	9,923
SUBSYSTEM & SYSTEM TEST	-	-	-	-	120,000	-	-	120,000	-
Specimens	-	-	-	-	-	-	-	-	120,000
ENGINE DEVELOPMENT	-	100,800	38,000	-	61,389	8,100	8,182	216,471	-
Specimens	-	5,212	60,310	-	35,506	7,972	-	109,000	325,471
FACILITY CHECKOUT	-	-	243,172	-	3,287	-	-	246,459	-
Specimens	1,415	3,664	20,018	3,914	10,179	1,548	389	41,077	287,536
MANUFACTURING MOCK-UP	119	-	2,181	436	440	-	-	3,176	-
Specimens	-	-	-	-	-	-	-	-	3,176
SYSTEMS BREADBOARD	-	-	17,200	-	-	-	56,000	73,200	-
Specimens	-	-	-	-	-	-	-	-	73,200
WIND TUNNEL	-	-	600	-	-	-	-	600	-
Specimens	-	-	-	-	-	-	-	-	600
TWO R&D FLIGHTS	16,628	28,230	236,364	55,300	48,402	-	17,500	452,424	-
Specimens	9,622	24,923	136,162	26,621	69,235	10,531	2,808	279,402	731,826
"B" SUBTOTALS TEST	18,120	136,003	607,880	58,551	238,756	8,100	119,079	\$1,186,489	-
SPECIMENS	12,943	38,736	243,460	35,808	128,633	22,136	3,103	484,819	-
"B" TOTAL	\$14,435	\$350,743	\$774,746	\$39,059	\$340,787	\$30,236	\$121,302	\$ -	\$1,671,308

"B" COST CATEGORIES

TABLE 1.0.0.0-III

MLLV - MAIN STAGE

COST ELEMENTS	LABOR					MATERIAL			TOOLING		FAC. & EQUIP.	TOTAL
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Test	Q&RA	Mfg.	Logistics	Q&RA	Labor	Mtl.		
STRUCTURES												
Fwd. Skirt	\$ 93	\$ 22	\$ 1,419	\$ 70	\$ 291	\$ 276	\$ 23	\$ 9	\$ 108	\$ 17	\$ 25	\$ 2,358
LH ₂ Tank	204	319	2,916	144	598	1,963	269	19	223	35	52	6,742
LOX Tank	184	576	2,394	118	491	670	512	15	183	29	43	5,215
Tunnels	64	230	823	41	169	287	205	5	63	10	15	1,912
Thrust Str.	217	217	1,727	85	355	172	194	11	132	21	31	3,162
Base Plug	53	384	504	24	104	223	341	3	39	6	9	1,690
Assembly	107	1,318	586	29	121	4	159	3	45	7	11	2,390
Structure Totals	922	3,066	10,369	511	2,129	3,595	1,703	65	798	125	186	23,464
SYSTEMS												
Prop./Mech.	681	1,124	9,847	486	2,020	23,575	808	62	751	119	176	39,649
Electrical	640	376	9,600	473	1,970	612	425	60	733	115	172	15,176
Instrumentation	305	1,009	3,903	192	801	718	740	25	298	47	70	8,108
Flt. Control	81	179	1,108	54	225	2,249	159	6	85	13	20	4,182
Systems Totals	1,707	2,688	24,458	1,205	5,019	27,154	2,132	153	1,867	294	438	67,115
ENGINES*	-	2,400	24,840	3,300	-	16,560	-	-	-	3,700	-	50,800
ENGINE INSTL.	39	-	576	58	124	5	-	3	44	7	9	865
PROPELLANT	-	-	-	-	-	3,287	-	-	-	-	-	3,287
I. U.*	-	-	5,608	-	-	3,738	-	-	-	-	-	9,346
SDF OPS.	-	1,727	4,442	-	-	-	-	-	-	-	-	6,169
LAUNCH OPS.	8,315	14,115	143,182	-	27,650	-	-	97	-	-	-	193,359
LAUNCH MAINT.	-	-	-	-	-	-	-	-	-	-	8,750	8,750
FAC. MAINT. & TRANSP.	-	-	-	-	-	-	-	-	-	-	3,972	3,792
SE&I	-	5,301	-	-	-	-	-	-	-	-	-	5,301
MAIN STAGE TOTAL	\$10,983	\$29,297	\$213,475	\$5,074	\$34,922	\$54,339	\$3,835	\$318	\$2,704	\$4,126	\$13,355	\$372,428

*MANUFACTURING COSTS FACTORED 60/40% INTO LABOR AND MATERIAL

"C" COST CATEGORIES

TABLE 1.0.0.0-IV

MLLV - ENGINE MODULE + TWO FUEL MODULES

COST ELEMENT	LABOR		MAT'L	TOOLING				EQUIP. & FAC.	TOTALS
	Mgmt. & Adm.	Vehicle Eng.	Misc.	Tooling Design	Tooling Mat'l.	Mfg. & Set-Up	Tooling Q&RA		
STRUCTURES - ENG. MOD.									
Fwd. Skirt	\$ 568	\$ 1,061	\$ 43	\$2,070	\$1,111	\$ 7,330	\$1,433	\$ -	\$ 13,816
LH ₂ Tank	566	2,121	87	1,699	908	6,704	1,311	-	13,396
LOX Tank	279	2,121	87	703	377	2,490	487	-	6,544
Tunnels	71	849	43	126	68	447	88	-	1,692
Thrust Structure	702	1,061	43	2,593	1,407	9,220	1,802	-	16,828
Assembly	39	849	43	-	-	-	-	-	931
Structures Total	2,225	8,062	346	7,191	3,871	26,191	5,121	-	53,007
STRUCTURES - FUEL MOD.	29	655	26	-	-	-	-	-	710
SYSTEMS									
Prop. & Mech.	253	4,243	174	184	99	654	128	-	5,735
Electrical	144	2,546	104	83	110	292	58	-	3,337
Instrumentation	330	6,364	261	75	104	276	54	-	7,467
Flight Control	149	1,697	70	282	151	963	188	-	3,500
Assembly	310	6,364	261	-	-	-	-	-	6,935
Systems Total	1,186	21,214	870	627	464	2,185	428	-	26,974
ENGINES	-	14,000	-	-	-	21,400	-	19,465	54,865
GSE	270	-	-	-	1,403	4,788	938	-	7,399
MANUFACTURING FACILITY	-	-	-	-	-	-	-	53,395	53,395
LAUNCH COMPLEX	-	-	-	-	-	-	-	2,100	2,100
INJECTION STG. TOTALS	\$3,710	\$43,931	\$1,242	\$7,818	\$5,738	\$54,564	\$6,487	\$74,960	\$198,450

"A" COST CATEGORIES

MLLV - ENGINE MODULE + FUEL MODULE

TABLE 1.0.0.0-V

TYPE OF TESTS	LABOR				MTL.	TOOLING	EQUIP. & FAC.	SUB- TOTALS	TOTALS
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Q&RA					
STATIC LOAD TEST - E/M Specimens	\$ 102 322	\$ 719 793	\$ 1,503 4,544	\$ 56 888	\$ 161 1,658	\$ - 363	\$ - 77	\$ 2,541 8,665	\$ - 11,206
STATIC LOAD TEST - F/M Specimens	16 377	102 930	256 5,329	10 1,041	46 1,943	- 449	- 91	430 10,160	- 10,590
DTV TEST - E/M Specimens	124 293	833 722	1,553 4,133	291 808	468 1,507	- 348	850 70	4,119 7,881	- 12,000
DTV TEST - F/M Specimen	- 498	- 1,228	- 7,034	- 1,375	- 2,565	- 592	850 120	850 13,412	- 14,262
MFG. DEVELOPMENT - E/M Specimen	75 -	- -	1,355 -	271 -	- -	- -	- -	1,701 -	- 1,701
SYSTEMS TEST - E/M Specimen	- -	- -	- -	- -	20,000 -	- -	- -	20,000 -	- 20,000
ENG. DEVELOPMENT - E/M Specimen	- -	53,400 -	78,100 -	- -	17,971 -	4,300 -	5,800 -	159,471 -	- 159,471
FACILITY VEH. - E/M Specimen	- 362	- 893	15,095 5,114	- 1,000	365 1,865	- 431	- 87	15,460 9,752	- 25,212
FACILITY VEH. - F/M Specimen	- 387	- 956	15,054 5,476	- 1,070	730 1,997	- 461	- 95	15,784 10,442	- 26,226
MFG. MOCK-UP - E/M Specimen	30 -	- -	545 -	109 -	109 -	- -	- -	793 -	- 793
SYST. BREADBOARD - E/M Specimen	- -	- -	1,215 -	- -	- -	- -	6,000 -	7,215 -	- 7,215
SYST. BREADBOARD - F/M Specimen	- -	- -	1,076 -	- -	- -	- -	3,500 -	4,576 -	- 4,576
TWO R&D FLIGHTS (2) EM Specimen	1,396 1,384	2,371 3,416	24,048 19,561	4,644 3,823	747 7,135	- 1,647	- 333	33,206* 37,299**	- 70,505
FM Specimen	591 1,299	1,003 3,205	10,174 18,355	1,965 3,587	1,467 6,694	- 1,546	- 314	15,200 35,000	- 50,200
"B" SUBTOTAL: TEST SPECIMEN	2,334 4,922	58,428 12,143	149,974 69,546	7,346 13,592	42,064 25,364	4,300 5,857	16,900 1,187	- -	- -
"B" GRAND TOTALS	\$7,256	\$70,571	\$219,520	\$20,938	\$67,428	\$10,157	\$18,087	-	\$413,957

"B" COST CATEGORIES

TABLE 1.0.0.0-VI

MLLV - ENGINE MODULE + F/M

COST ELEMENTS	LABOR					MATERIAL			TOOLING		FAC. & EQUIP.	TOTAL
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Test	Q&RA	Mfg.	Logistics	Q&RA	Labor	Mtl.		
STRUCTURES												
Fwd. Skirt	\$ 83	\$ 26	\$ 1,282	\$ 65	\$ 262	\$ 507	\$ 22	\$ 8	\$ 98	\$ 14	\$ 25	\$ 2,393
LH ₂ Tank	177	183	2,591	127	532	466	171	15	179	30	48	4,537
LOX Tank	135	183	1,949	97	398	159	171	12	150	22	35	3,311
Tunnels	47	127	625	32	128	29	113	1	47	9	12	1,170
Thrust Str.	38	153	458	23	96	219	136	3	35	6	8	1,175
Assembly	178	362	2,375	162	494	13	327	13	248	32	56	4,260
Structure Totals	658	1,034	9,280	506	1,910	1,393	940	52	775	113	185	16,846
SYSTEMS												
Prop. & Mech.	155	333	2,148	105	444	2,570	295	14	164	27	38	6,293
Electrical	142	128	2,096	102	431	59	114	13	160	23	37	3,305
Instrumentation	71	320	851	41	176	68	285	5	64	12	15	1,908
Flight Control	18	64	242	13	49	187	57	1	19	4	5	659
Systems Totals	386	845	5,337	261	1,100	2,884	751	33	407	66	95	12,165
ENGINES	-	391	6,160	452	-	349	-	-	201	-	-	7,553
ENGINE INSTL.	7	-	141	6	26	2	-	1	12	-	3	
PROPELLANT	-	-	-	-	-	1,074	-	-	-	-	-	1,074
LAUNCH OPS.	1,089	2,035	18,245	-	3,598	-	-	134	-	-	-	25,101
FACILITY & TRANSPORTATION	-	-	-	-	-	-	-	-	-	-	1,310	1,310
TOTAL	\$2,140	\$4,305	\$39,163	\$1,225	\$6,634	\$5,702	\$1,691	\$220	\$1,395	\$179	\$1,593	\$64,247

"C" COST CATEGORIES

TABLE 1.0.0.0-VII

MLLV - SRM STAGE

COST ELEMENT	LABOR		MAT'L Misc.	TOOLING				FAC. & EQUIP.	TOTAL
	Mgm't & Adm.	Vehicle Engr.		Tooling Design	Tooling Mat'l.	Mfg. & Set-Up	Tooling Q&RA		
DELTA FWD SKIRT	\$ 828	\$1,696	\$ 70	\$2,976	\$ 1,560	\$10,539	\$2,060	\$ -	\$ 19,729
STRUCTURE									
Aft Skirt	147	123	5	585	313	1,974	386	-	3,533
SRM Fittings	50	74	3	193	103	652	127	-	1,202
Attach Structure	777	435	18	3,133	1,676	10,566	2,066	-	18,671
Nose Cone	387	188	8	1,573	841	5,305	1,037	-	9,339
Total Structures	1,361	820	34	5,484	2,933	18,497	3,616	-	32,745
SRM MOTOR	395	1,795	-	714	41,227	-	-	-	44,131
LAUNCH COMPLEX FACILITIES	-	-	-	-	-	-	-	162,470	162,470
MFG. FACILITY (FIXED)	-	-	-	-	-	-	-	8,434	8,434
SRM GSE (FIXED)	-	-	-	-	-	-	-	3,072	3,072
SRM TOTAL (FIXED)	2,584	4,311	104	9,174	45,720	29,036	5,676	173,976	270,581
SRM QUANTITATIVE SENSITIVE									
GSE	-	-	-	-	-	-	-	15,690	15,690
Facility	-	-	-	-	-	-	-	42,170	42,170
TOTAL	-	-	-	-	-	-	-	57,860	57,860
SRM GRAND TOTAL	\$2,584	\$4,311	\$104	\$9,174	\$45,720	\$29,036	\$5,676	\$231,836	\$328,441

"A" COST CATEGORIES

TABLE 1.0.0.0-VIII

MLLV - SRM

TYPE OF TESTS	LABOR					TOOLING	EQUIP. & FAC.	SUB- TOTALS	TOTALS
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Q&RA	MTL.				
STATIC LOAD Specimen	\$ 42 142	\$ 300 21	\$ 603 2,300	\$ 22 450	\$ 333 394	\$ - 194	\$ - 39	\$ 1,300 3,540	\$ - 4,840
DYNAMIC TEST Specimen	31 191	211 29	404 3,091	61 604	294 530	- 260	12,750 52	13,751 4,757	- 18,508
MANUFACTURING DEV. Specimen	13 -	- -	74 -	15 -	16 -	- -	- -	118 -	- 118
PFRT Specimen	1,538 -	7,415 -	8,972 6,565	1,428 1,928	- 78,196	- -	11,074 -	30,427 86,689	- 117,116
"F" VEHICLE Specimen	- -	- -	23,100 537	- 158	- 6,424	- -	- -	23,100 7,119	- 30,219
SYSTEMS BREADBOARD Specimen	- -	- -	1,075 -	- -	3,500 -	- -	- -	4,575 -	- 4,575
WIND TUNNEL Specimen	- -	- -	- -	- -	400 -	- -	- -	400 -	- 400
STRUCTURAL Specimen	- 109	- 213	388 1,654	- 344	216 481	- 75	263 28	867 2,922	- 3,789
TWO R&D FLIGHTS: "B" COSTS Specimen	1,995 1,535	3,081 3,632	34,094 30,123	6,652 6,817	582 104,796	176 1,054	66 1,594	46,656 149,551	- 196,207
SUB-TOTALS: "B" COSTS Specimens	3,619 1,977	11,017 3,913	68,710 44,270	8,178 10,301	5,341 190,821	176 1,583	24,153 1,718	- -	- \$375,772
"B" GRAND TOTAL	\$5,596	\$14,930	\$112,980	\$18,479	\$196,162	\$1,759	\$25,866		

"B" COST CATEGORIES

TABLE 1.0.0.0-IX

MLLV - SRM

COST ELEMENTS	LABOR					MATERIAL			TOOLING		FAC & EQUIP.	SUB- TOTAL	TOTAL
	Mgmt. & Adm.	Engr.	Mfg. & Ops.	Test	Q&RA	Mfg.	Logistics	Q&RA	Labor	Mtl.			
SRM - FIXED													
Delta Fwd. Skirt	\$ 125	\$ 65	\$ 1,839	\$ 90	\$ 377	\$ 200	\$ 46	\$12	\$ 140	\$ 23	\$ 33	\$	\$ 2,950
Launch Main.	-	-	-	-	-	-	-	-	-	-	1,150	-	1,150
Launch Ops.												3,455	3,219
Launch Control	138	235	2,384	-	460	-	-	2	-	-	-	6,314	5,889
Launch Pad	251	426	4,324	-	835	-	-	3	-	-	-	10,107	11,320
Off Site Support	487	826	8,382	-	1,619	-	-	6	-	-	-	-	-
Launch Ops. Sub-Total	876	1,487	15,090	-	2,914	-	-	11	-	-	-	20,378	20,378
SRM FIXED TOTAL	1,001	1,699	16,328	90	3,265	200	46	23	140	23	1,183	-	24,478
SRM QUANTITY SENSITIVITY												1ST UNIT	8 UNITS
STRUCTURES													
Attach. Structure	411	651	5,930	182	1,231	1,215	302	36	455	72	109	10,594	
Nose Cone	189	465	2,552	87	540	506	217	14	196	29	44	4,839	
Aft Skirt	123	370	1,645	87	350	341	174	7	196	22	29	3,344	
Fittings	94	463	1,027	87	225	211	218	7	80	7	22	2,441	
Str. Sub-Total	817	1,949	11,154	443	2,346	2,273	911	64	927	130	204	21,218	21,218
MOTOR	-	-	4,765	-	1,016	38,527	-	-	-	-	-	-	44,308
OTHER STAGE	-	-	-	-	-	11,828	-	-	-	-	-	-	11,828
FACILITY MAINT.	-	-	-	-	-	-	-	-	-	-	733	-	733
SRM QTY. SENSTV. TOTAL													78,087
SRM GRAND TOTAL	\$1,818	\$3,501	\$32,848	\$533	\$6,653	\$52,828	\$957	\$87	\$1,067	\$153	\$2,120		\$102,565

"C" COST CATEGORIES

1.0 (Continued)

of SRM stage costs because of the high percentage of purchased propellant, materials and stage components.

With the details provided in the three Cost Books comprising Volume V, several program options exist such as the types of engines, launch facilities, program size, etc. Figure 1.0.0.0-14 illustrates how costs can be identified from the detail data to evaluate one of these options. Options one, two, three and four show the costs of the MLLV multichamber/plug propulsion system, the 1200 psia toroidal/aerospike with the 286,000 pound thrust module (28 modules), the 1200 psia toroidal/aerospike with the one million pounds thrust/module (8 modules) and the 2000 psia toroidal/aerospike with the one million pounds thrust/module (8 modules), respectively. The "A", "B" and "C" costs are shown for the MLLV with the propulsion costs deleted. The total program costs incorporating each propulsion option are also shown. Similar comparisons can be made for other program options. These will be discussed in Volume VI of this final report.

This Volume V, Baseline MLLV Costs primarily presents only the cost data. Applications for these costs, for cost effectiveness analyses and cost sensitivity studies, can be found in Volume VI (Cost Implications of Vehicle Size, Technology, Configurations and Program Options).

DOLLARS IN THOUSANDS

PROPULSION SYSTEM OPTIONS	GET READY "A" COST	DEVELOPMENT TEST "B" COST	PRODUCTION "C" COST
<u>Engine Option Number One</u> Multichamber/Plug Propulsion System	\$ 118,395	\$ 325,471	\$ 50,800
<u>Engine Option Number Two</u> Toroidal/Aerospike Propulsion System 286K Lbs. Thrust/Module - 28 Modules 1200 PSIA Chamber Pressure	57,995	108,471	32,800
<u>Engine Option Number Three</u> Toroidal/Aerospike Propulsion System One Million Lbs. Thrust/Module - 8 Modules 1200 PSIA Chamber Pressure	62,295	169,671	23,200
<u>Engine Option Number Four</u> Toroidal/Aerospike Propulsion System One Million Lbs. Thrust Module - 8 Modules 2000 PSIA Chamber Pressure	65,195	195,271	23,500
Single Stage to Orbit Vehicle Cost (Less Propulsion System)	\$ 986,241	\$1,345,837*	\$321,628
Single Stage to Orbit with Multichamber/Plug	1,104,636	\$1,671,308*	\$372,428
Single Stage to Orbit with Toroidal/Aerospike 286K Lbs. Thrust Module 28 Modules - 1200 PSIA	1,231,914	\$1,454,308*	\$354,428
Single Stage to Orbit with Toroidal/Aerospike One Million Lbs. Thrust/Module 8 Modules - 1200 PSIA	1,236,614	\$1,515,508*	\$344,828
Single Stage to Orbit with Toroidal/Aerospike One Million Lbs. Thrust/Module 8 Modules - 2000 PSIA	1,239,114	\$1,541,108*	\$345,128

*Two R&D Flight Tests = \$731,826. Costs are Included in "B" Costs

FIGURE 1.0.0.0-14 PROPULSION SYSTEM OPTIONS FOR THE MLLV SINGLE STAGE VEHICLE

2.0 STUDY OBJECTIVES, GROUND RULES AND ASSUMPTIONS, PRICING FACTORS AND LABOR RATES

2.1 STUDY OBJECTIVES

This study, "Cost Studies of Multipurpose Large Launch Vehicles", was directed to define the economical aspects of future launch vehicle systems. To accomplish this objective, the half size vehicle (MLLV) family as defined in Volume II of this final report was subjected to a detailed cost analysis. This cost analysis included both the non-recurring and recurring costs for implementation and operation of the baseline MLLV vehicle family. This volume reports the results of this cost analysis. A similar analysis was conducted on the full size vehicle (AMLLV) family as defined by the previously completed study, "Advanced Multipurpose Large Launch Vehicle", Contract NAS2-4079 (Baseline AMLLV). The full size AMLLV cost analysis is reported in Volume IV.

2.2 GROUND RULES AND ASSUMPTIONS

The following ground rules, guidelines, and assumptions were utilized in the cost analysis of the baseline MLLV vehicle family:

- a. Production and launch rates are based on two vehicles per year.
- b. Cost estimates were based on 1968 dollars without inflationary factors.
- c. All cost values in this report are contractors cost values only and do not include profit or fee, with the exception of the Solid Rocket Motors and liquid engines.
- d. The first unit has been defined as the first flight vehicle; effects of learning curve(s) enter after that unit.
- e. Where possible, the cost estimates were based on direct costs with burdens added as a separate item.
- f. The R&D flight vehicles consist of two vehicles.
- g. The facility checkout vehicle includes structural hardware, transportation and the complete launch cycle cost.
- h. Static firing of the vehicles will occur at the launch pad.

2.2 (Continued)

i. Resource Inputs

Resource inputs for recurring and non-recurring items were received from functional organizations within The Boeing Company and from propulsion contractors (Aerojet General, Pratt and Whitney, and Rocketdyne). Most of the direct inputs were in terms of manhours; however, total dollar costs were also received for several items; i. e., material, equipment, engines, etc.

The Manufacturing Department at the Michoud Assembly Facility and the Huntsville Operations Department provided manhours and material estimates for the following items: 1) Fabrication, Major and Minor Assembly of the Sub-System Components, 2) Manufacturing Test manhours, 3) Raw and Production Material, 4) Planning manhours, 5) Tool Design manhours, 6) Tool Fab. and Erection hours, 7) Manufacturing Development hours, and 8) MGSE and Handling/Transportation Equipment hours and dollars.

The Huntsville Engineering Department provided basic engineering design and sustaining engineering manhours. The Facilities Department at Huntsville, BATC and Michoud provided costs of the brick and mortar facilities for production, test and launch; transportation and handling equipment; capital equipment and maintenance costs. The Test Organization at Huntsville provided manhours and costs for conducting Developmental Testing, Structural Tests, Systems Development (SDF), Systems Test, Dynamic Tests, Manufacturing Development and Wind Tunnel Tests.

The Engineering Department at BATC provided costs for Launch Operations and Launch Vehicle Ground Support Equipment (LVGSE) and Test Equipment.

The propulsion contractors provided costs for the solid rocket motors, toroidal/aerospike engine and the multichamber/plug engines. The liquid engine data was supplemented with data received from the Propulsion Office at NASA/MSFC.

The details associated with these direct inputs are displayed and summarized in the "Resources Implications" Volume III of this report.

2.3 PRICING FACTORS

Once the data was received by the Cost Estimating Organization, elemental and overall costs were developed; the direct cost elements were totaled with the associated indirect and supporting costs. These direct and supporting costs include but are not necessarily limited to: Quality Control, Program Management,

2.3 (Continued)

Planning, Training, etc. These will be discussed, in detail, in the paragraphs that follow.

The cost collection summary form is divided into four basic parts:

Part I Program Management,

Part II The Contract End Item (CEI),

Part III Facilities,

Part IV Logistics.

Throughout this cost analysis, this format has been used to maintain consistency. On occasion, the category of "other" is included as a cost element to collect those elements which do not necessarily fit the established format. In those instances, a footnote has been provided to explain what items are included in the category of "other".

Part I Program Management, Program Planning and Reporting and Industrial Relations

These elements were applied by the costing organization: The weighing of such elements were based on historical Saturn V experience.

Part II Engineering, Production, Tooling and Manufacturing Test

Included in the Engineering costs, either basic or sustaining, are laboratory technicians support and the associated operating material costs. Included in production costs are direct factory labor for fabrication and assembly of the system or subsystem components, miscellaneous charges, tool and production planning, direct distributable labor, training, quality inspection, manufacturing technicians, raw material, and standards. Tooling cost, either basic or sustaining, include direct factory labor, direct distributables, training, quality and tooling material. Manufacturing test costs include the labor costs for component testing, training, technicians, and quality assurance.

Part III Facilities

Included are the costs for the brick and mortar buildings, stands, pads, etc., craft labor maintenance, transportation and handling labor, plant engineering support, and facilities maintenance costs.

2.3 (Continued)

Part IV Logistics

Included are the logistics support and the cost of spares, maintenance analysis and field support engineering labor costs.

The following in-depth explanation covers each major cost element as to their function and use:

Part I

- a. Program Executive - Function: Program office and equipment management; program assessment, problem identification, customer liaison; change board, change status, follow-up and commitment.

This element is a level of effort; however, for this study, a factor was developed from Saturn historical data. It was determined that this function was 1.2% of the direct labor manhours in Parts II through IV with the exception of launch operations which is .95%.

- b. Program Planning and Reporting (PP&R) - Function: Determination and development of product activities for planning purposes. Monitors performance and the processes of the management of the business.

PP&R is a pricing factor, developed from historical actuals. That is submitted (usually on an annual basis) to the NASA, negotiated, and used for forward pricing purposes. PP&R labor hours are developed by applying 3% to the total direct labor manhours in Parts II through IV below with the exception of launch operations which is 2.4%.

Material (consisting of graphics and aids) is required to support this function. A rate of 2¢ per PP&R manhour was used.

- c. Industrial Relations - Function: Health, safety and training operations. Industrial Relations is a pricing factor, developed from historical data. That is submitted (usually on an annual basis) to the NASA, negotiated, and used for forward pricing purposes. Industrial Relations labor hours are developed by applying .65% to the total direct manhour base in Parts II through IV below with the exception of launch operations which is .54%. For training aids and supplies, a rate of 10¢ per industrial relations manhour was used.

Part II

- a. Engineering

- 1. Design Activity Functions

2.3 (Continued)

- (a) Changes to the initial release of Class I documentation applicable to the procurement, fabrication, assembly and test of the stage.
- (b) Liaison - Liaison with manufacturing, quality control, procurement, vendors and testing functions are required to resolve discrepancies.
- (c) Failure Analysis - Investigations, analyses and studies of anomalies and failures.
- (d) Flight Test Evaluation - Provide data for flight performance predictions, measurement and data acquisition requirements, statistical analysis and flight performance evaluation.
- (e) Design Change Implementation of in-scope design changes resulting from remedial engineering and cost and producibility activities.

2. Test Functions:

- (a) Maintenance of test procedures
- (b) Test planning
- (c) Fixture and instrumentation
- (d) Conduct tests
- (e) Data reduction and evaluation
- (f) Preparation of test reports

3. Configuration Management Functions:

- (a) Preparation and maintenance contract specification addenda
- (b) Interface control
- (c) Delivery support of the end item acceptance data package

4. Reliability Engineering Functions:

- (a) Continuing technical management and surveillance of the reliability program

2.3 (Continued)

- (b) Reliability design analyses of design changes
- (c) Reliability surveillance for design reviews
- (d) Failure analyses
- (e) Reliability testing
- (f) Flight test evaluation

The engineering manhours for "a" through "d" above, both recurring and non-recurring functions, were received as a direct input to the study.

- b. Laboratory Technicians - Function: Shop support to engineering, qualification and reliability testing in the form of test set-up, test specimens, special or peculiar test equipment. These laboratory technicians support engineering, and are a function thereof.

A review of the historical Saturn data indicated, that on a composite basis, this effort was approximately 20% of the direct engineering manhours (Part II, paragraph a above). Therefore, for the purpose of this study, the factor of 20% was applied to the MLLV engineering manhours to estimate laboratory technician manhours.

The materials required to support these technicians were priced at \$2.10 per laboratory technician manhour.

- c. Fabrication and Assembly - Function:

- 1. Fabrication - direct labor necessary to manufacture the individual detail parts
- 2. Minor Assembly - direct labor necessary to join together the major sections, installation of equipment and systems and assembly of major sub-assemblies.

The direct manhours to accomplish fabrication, minor and major assembly were a direct input to the study by the Boeing/Michoud Manufacturing Department.

- d. Miscellaneous Charges - Functions:

- 1. Process control
- 2. Part numbering and stamping

2.3 (Continued)

3. Certification of welding and plating process
4. Cutter grinding
5. Other items not readily identifiable to hardware

It is reasonable to assume that in a normal production program, similar or related functions of this nature would be required. Therefore, a review of Saturn history indicated that this type of effort was approximately 7.8% of the fabrication and assembly manhours. This factor was applied to the MLLV fabrication and assembly manhours.

- e. Maintenance and Incorporation of In-Scope Changes - Function: Maintenance and incorporation of in-scope changes to component and sub-system test requirements for fabrication and/or rework of parts, drawers, etched cards, etc.

This effort was determined to be 1.1% of fabrication and assembly manhours on the Saturn V program and, therefore, that factor was applied to the MLLV fabrication and assembly manhours.

- f. Tool and Production Planning - Function:

1. Sustaining planning for: Procurement; Fabrication; Assembly and Installation.
2. Translation of engineering designs and specifications; into work plans and task descriptions.
3. PERT support: By maintaining PERT networks; update to PERT documentation and PERT status of the manufacturing operations.

It was determined, from historical Saturn data, that tool and production planning was approximately 28% of the production and tool sustaining manhours. This percentage was applied to the MLLV production (Part II, Paragraphs 3 through 5) and tool sustaining manhours (Part II, Paragraph 12) to determine the tool and production planning manhours.

- g. Direct Distributable - Function: Production order control - dispatch clerks, parts control clerks, production order control clerks, production controllers, factory clerks, production control records (PCR), design accounting, PCR clerks, parts listers, tool room attendants, tool procurement, coordinators, blueprint control clerks, shipping, craters, and packaging engineers; chemical and LOX cleaning.

2.3 (Continued)

Direct distributable was estimated on the basis of historical Saturn data at approximately 32% of total production manhours. The MLLV direct distributed manhours may be determined by applying 32% of the production manhours (Part II, Paragraphs 3 through 5).

- h. Training - Function: Train and orient new and/or existing personnel. Based on historical experience, it was determined that training manhours were a function of the manhours for Part II, Paragraphs 3, 4, 5, 6, 7 and 12. By applying a factor of 1.1% to the MLLV manufacturing base training manhours may be estimated.
- i. Quality - Function:
 - 1. Source control
 - 2. Reliability data collection and analysis
 - 3. Quality program documentation
 - 4. Inspection stamp control
 - 5. Reliability audits
 - 6. Design review
 - 7. Quality audits
 - 8. Fabrication and assembly inspection
 - 9. Functional test and stage test inspection
 - 10. Configuration accountability and product delivery
 - 11. Procurement planning
 - 12. Laboratory material analysis
 - 13. Process control
 - 14. Contamination control
 - 15. Non-destructive testing
 - 16. Equipment quality analysis

2.3 (Continued)

17. Discrepancy control area

18. Measurement control

Normally, quality support is a direct input; however, for the purpose of this study quality was factored into the total manhours (Part II, Paragraphs 2 through 7 and 12) associated with the contract end item (CEI) hardware. A factor of 20% was applied to the MLLV CEI hardware manhours to develop the quality support. In addition, \$.30 per quality manhour was used to estimate the material required to support this function.

- j. Manufacturing Technology - Function: Conduct process development programs to assure reliable manufacture of stage hardware and mechanical support equipment.

Manufacturing technology is a pricing factor, developed from historical data, that is submitted (usually on an annual basis) to the NASA, negotiated, and used for forward pricing purposes. The current factor is 1.9%. The MLLV manufacturing technician manhours may be determined by applying this factor to all direct manhours (Part II, Paragraphs 3 through 8). Material costs, to support this function, were based on \$1.75 per manufacturing technology manhour.

- k. Raw Material and Standards - Includes the raw material, standards, purchased parts, equipment, major sub-systems, technical services and maintenance repair and operating (MRO) supplies and services associated with the production of the Contract End Item (CEI).

Estimates for material costs were received from the Boeing/Michoud Operations Department in terms of dollar estimates.

- l. Tool Sustaining - Function:

1. Support previously fabricated basic tooling
2. Repair and maintenance of major tools
3. Manufacturing changes
4. Vendor deficiencies
5. Lost and worn tools

2.3 (Continued)

Tool sustaining is a pricing factor, developed from historical data. That is submitted (usually on an annual basis) to the NASA, negotiated, and used for formal pricing purposes. Tool sustaining manhour for the MLLV are determined by applying 8% to Part II, Paragraphs 3, 4, and 5 above.

m. Manufacturing Test - Function:

1. Maintain test procedures
2. Planning the testing of stage components
3. Testing stage and mechanical support equipment systems, sub-systems and components

The manufacturing test manhours were received from the Boeing/Michoud Operations Department as a direct input to the study.

Part III

Facilities Labor - Function:

- a. Equipment management
- b. GIS equipment management
- c. Engineering support

For this study, it was estimated that this type of facilities labor would be 3% of direct fabrication and assembly manhours (Part II, Paragraph 3).

Part IV

Logistics - Function:

- a. Logistics engineering for maintenance analysis
- b. Technical manuals
- c. Field support engineering

The logistics manhours were a direct input from Boeing/Michoud Engineering Department. Logistics hardware, or spares, were estimated at \$56 per engineering hour.

2.4 LABOR RATES

The labor rates used for this cost analyses are intended to be typical of the Aerospace industry. The development of these rates were based on a composite of the skill mixes (i.e., various levels and grades of supervision, engineers, technician, hourly and general salary type individuals). The rates are based on 1968 dollars without inflationary factors. The rates for program effort (exclusive of launch operations) were submitted to the Program Office at NASA-MSFC and verbal concurrence was received that they were within the industry average. (The launch operations rates were a Boeing best estimate based on 1968 actuals.)

Two types of labor rates were developed: (1) engineering, and (2) manufacturing. The various cost elements used in this study were classified into either of these two categories as follows:

- a. The engineering rates are applicable to:
 - 1. Engineering
 - 2. Logistics
 - 3. Program Management
 - 4. Program Planning and Reporting
 - 5. Manufacturing Technicians
- b. The manufacturing rates are applicable to:
 - 1. Laboratory Technicians
 - 2. Quality
 - 3. Direct Distributable
 - 4. Tool Sustaining
 - 5. Production
 - 6. Industrial Relations
 - 7. Training
 - 8. Facilities

2.4 (Continued)

In actual practice, each of the above cost elements would have a separate composite labor rate; however, for the purpose of this study and to keep the number of rates and/or calculations to a minimum, the above grouping was effected.

As a relatively significant difference in rates was found between those of the launch complex and those of other sites, a separate set of labor rates were developed and applied to activities conducted at the launch complex.

The resulting rates used for the cost analyses including applicable fringe benefits, other burdens and G&A are as follows:

<u>Program Exclusive of Launch Operations</u>	<u>Engineering</u>	<u>Manufacturing</u>
Base Labor Rate	\$ 6.43	\$4.26
Fringe Benefits	<u>1.51</u>	<u>1.00</u>
Subtotal	\$ 7.94	\$5.26
Other Burden & G&A	<u>3.87</u>	<u>4.46</u>
Total	<u>\$11.81</u>	<u>\$9.72</u>
<u>Launch Operations</u>	<u>Engineering</u>	<u>Manufacturing</u>
Base Labor Rate	\$6.00	\$4.92
Fringe Benefits	<u>1.38</u>	<u>1.13</u>
Subtotal	\$7.38	\$6.05
Other Burden & G&A	<u>2.20</u>	<u>1.78</u>
Total	<u>\$9.58</u>	<u>\$7.83</u>

NOTE: This is the first book (Book A) of the three books which comprise Volume V, Baseline MLLV Cost, of the final documentation for "Cost Studies of Multipurpose Large Launch Vehicles." This Book A contains Section 3.0, MLLV Get Ready "A" Cost. Book B contains Section 4.0, MLLV Development Test "B" Costs. Book C contains Section 5.0, MLLV First Unit "C" Cost. The pages in this volume are numbered sequentially in Book A through Book C.

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3.0 GET READY OR "A" COSTS

This section contains a detailed breakdown of the non-recurring - get ready or A costs. These are all of the costs associated with "Getting Ready" to produce and operate the first production article (e.g., basic design, Brick and Mortar Facilities, Tooling, Fabrication and Erection, etc.). The Resource Data was received from the affected working organizations in terms of the required manhours, materials, tooling, equipment and facilities. On this basis, elemental and overall costs were developed. The direct cost increments were sequentially totaled with factored indirect and supporting costs based on current and historical data. These indirect and supporting costs include the costs for quality control, program management, planning, training, structures, other program associated elements, overhead and/or burden costs and G&A. These costs are also expressed in terms of manhours and material dollars to the component level for each of the selected vehicles.

The preceding Figure 1.0.0.0-11 illustrates the Get Ready Cost flow diagram. Costs shown for the single stage vehicle include all of the costs as necessary to get ready to build the vehicle, GSE, manufacturing facility and launch complex. The costs shown for the injection stage single module (engine module) includes similar costs. Where the same manufacturing facility and launch facility will be used by both the main (single stage) and the injection stage modules, costs were apportioned between the stage components. Similarly, costs of the injection stage fuel module, solid motor fixed cost and the solid motor quality sensitive costs are subdivided and contain proportional costs for launch facility, manufacturing facility, etc.

Each of these major headings are then further subdivided into its major cost items. The costs are included in the same box. The applicable paragraph number where back-up data has been presented is also shown in the box.

The lower level stage and system costs were developed, priced and summarized into the four major parts and their sub-division as defined in the previous Section 2.3.

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3.1 SINGLE STAGE VEHICLE

The total Get Ready or "A" costs for the Single Stage MLLV vehicle are displayed in Table 3.1.0.0-I. These costs include the costs associated with designing the hardware structures, systems, liquid engines, Ground Support Equipment (GSE), the production facility and the Launch Complex Facility. Figure 3.1.0.0-1 displays these costs and the appropriate sub-paragraph number for each item included in the Single Stage Vehicle.

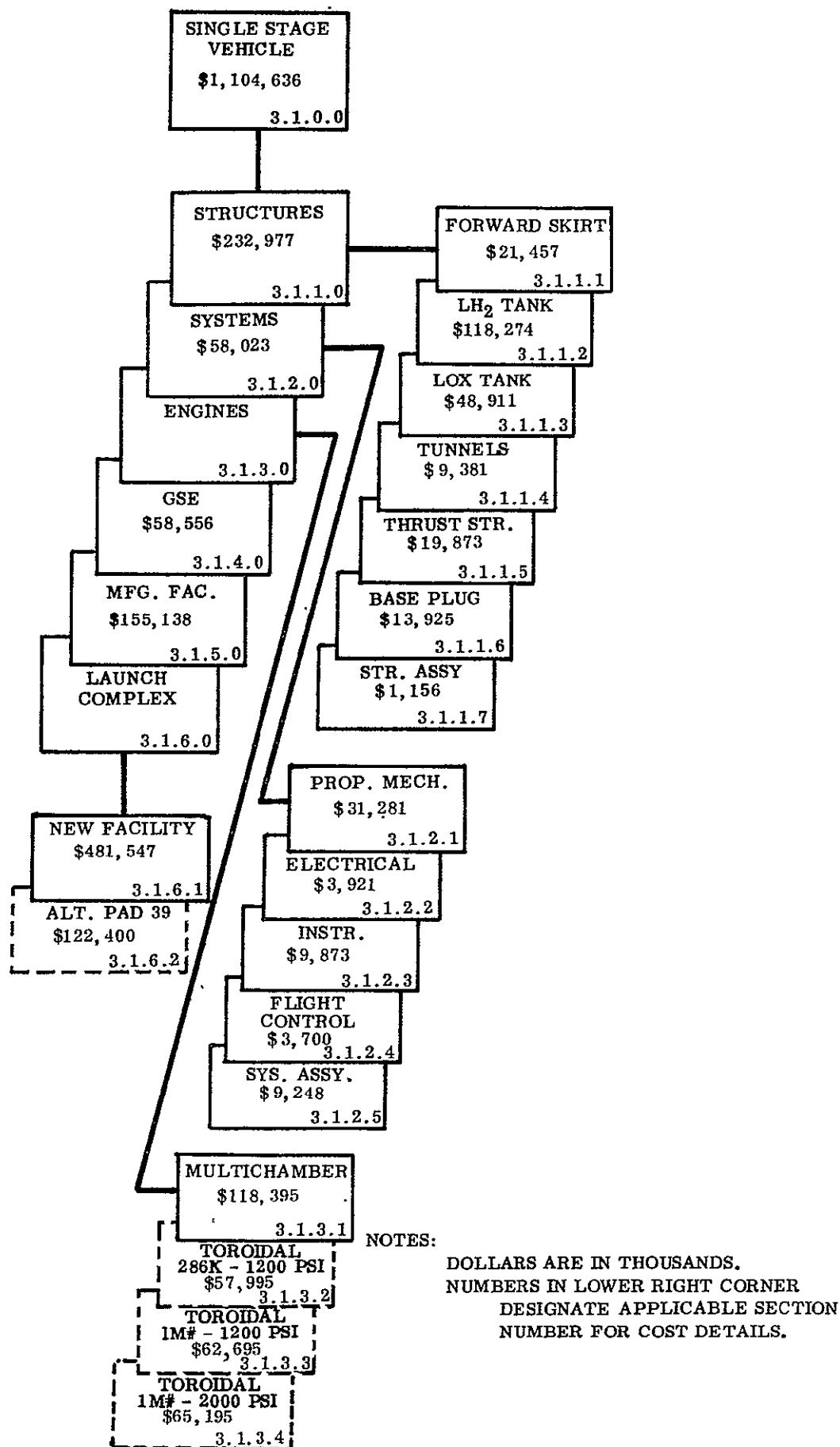


FIGURE 3.1.0.0-1 MLLV SINGLE STAGE TO ORBIT VEHICLE GET READY, "A" COSTS

SINGLE STAGE

TABLE 3.1.0.0-I
MLLV COST SUMMARYA ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	306	3,631								306	3,631
PROGRAM PLAN.& REPT.	770	9,084								770	7,084
INDUSTRIAL RELATIONS	168	1,616								168	1,616
ENGINEERING			6,054	97,890						6,054	97,890
LAB TECHNICIANS			1,212	11,766						1,212	11,766
TOOLING			13,677	165,252						13,677	165,252
PRODUCTION				8,000							8,000
MANUFACTURING TEST			648	6,296						648	6,296
MANUFACTURING TECH.			344	4,072						344	4,072
Q & R A			3,757	36,509						3,757	36,509
FACILITIES											
DIRECT DIST			3,628	35,250						3,628	35,250
TRAINING			198	1,921						198	1,921
TOTAL DIRECT LABOR	1,244	14,331	29,518	366,956						30,762	381,287
MATERIAL		30		26,065							26,095
LOGISTIC HARDWARE											
BURDEN		11		8,863							8,874
TOTAL MATERIAL		41		34,928							34,969
TOTAL OTHER					676780				11,600		688,380
TOTAL COST		14,372		401,884	676780				11,600		1,104,636

* SEE ENGINES

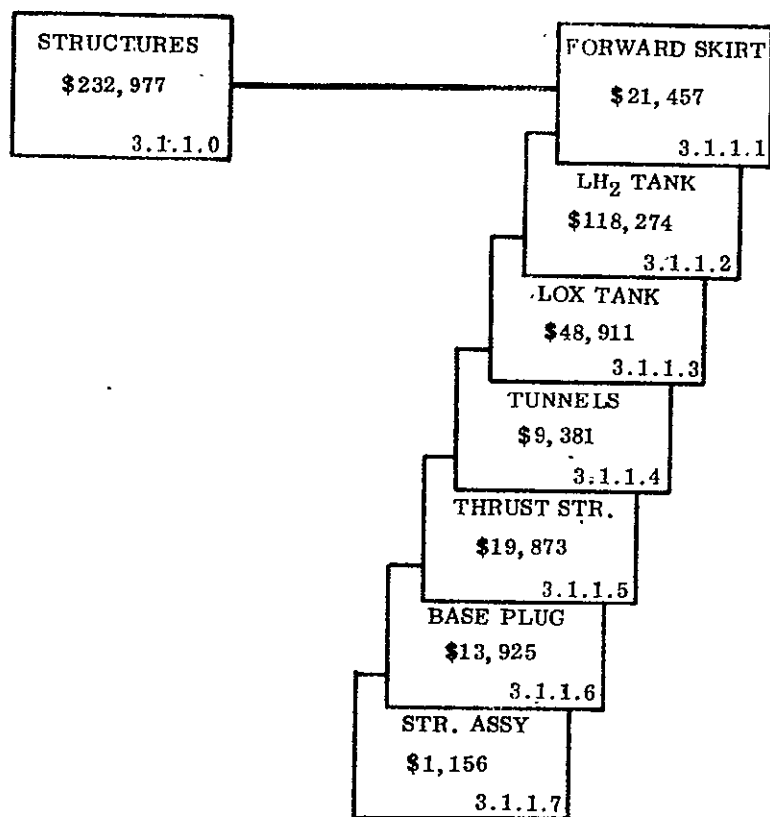
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3.1.1 Structures

The Get Ready cost for the structural components of the single stage vehicle are displayed in Figure 3.1.1.0-1. The cost details of the structural components are contained in appropriate subparagraphs, as indicated.

Table 3.1.1.0-I is a total cost summary of these structures.

These costs are comprised of Basic (or Non-Recurring) Engineering Costs which are required to produce the basic tooling, fabrication and assembly of tooling, and basic article design, including all engineering such as manufacturing liaison and coordination required to produce the first article. These costs are non-recurring in that they are experienced once during the production cycle.



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.1.1.0-1 MLLV MAIN STAGE STRUCTURES COSTS GET READY, "A" COSTS

TABLE 3.1.1.0-I
MLLV COST SUMMARY

STRUCTURES - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	207	2,458								207	2,458
PROGRAM PLAN.& REPT.	521	6,146								521	6,146
INDUSTRIAL RELATIONS	114	1,094								114	1,094
ENGINEERING			3,790	44,761						3,790	44,761
LAB TECHNICIANS			759	7,367						759	7,367
TOOLING			9,560	92,935						9,560	92,935
PRODUCTION											
MANUFACTURING TEST			453	4,401						453	4,401
MANUFACTURING TECH.			241	2,847						241	2,847
Q & R A			2,587	25,133						2,587	25,133
FACILITIES											
DIRECT DIST			2,536	24,641						2,536	24,641
TRAINING			139	1,342						139	1,342
TOTAL DIRECT LABOR	842	9,698	20,065	203,427						20,907	213,125
MATERIAL		21		14,792							14,813
LOGISTIC HARDWARE											
BURDEN		8		5,031							5,039
TOTAL MATERIAL		29		19,823							19,852
TOTAL OTHER											
TOTAL COST		9,727		223,250							232,977

3.1.1.1 Forward Skirt - Standard
(Lightweight Skirt)

TABLE 3.1.1.1-I

FORWARD SKIRT - SINGLE STAGE

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	18	218								18	218
PROGRAM PLAN.& REPT.	46	548								46	548
INDUSTRIAL RELATIONS	10	97								10	97
ENGINEERING			345	4,069						345	4,069
LAB TECHNICIANS			69	670						69	670
TOOLING			884	8,595						884	8,595
PRODUCTION											
MANUFACTURING TEST			42	407						42	407
MANUFACTURING TECH.			22	264						22	264
Q & R A			239	2,689						239	2,689
FACILITIES											
DIRECT DIST			234	1,899						234	1,899
TRAINING			13	124						13	124
TOTAL DIRECT LABOR	74	863	1,560	18,716						1,634	19,579
MATERIAL		2		1,377							1,379
LOGISTIC HARDWARE											
BURDEN		1		498							499
TOTAL MATERIAL		3		1,875							1,878
TOTAL OTHER											
TOTAL COST		866		20,591							21,457

MLLV

PART I

FORWARD SKIRT - S/S
 ASSEMBLY OR SYSTEM

TABLE 3.1.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	345		
Logistics			
Laboratory Technician	69		
Production			
Tooling	884		
Manufacturing Test			
Q&RA	228		
Facilities			
Manufacturing Technician	21		
Total Direct Labor	<u>1,547</u>		
Program Executive		18	218
Program Planning & Reporting		46	548
Industrial Relations		<u>10</u>	<u>97</u>
Total Labor - Part I		<u>74</u>	<u>863</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			<u>1</u>
Total Material			<u>3</u>
TOTAL COST - PART I			<u>866</u>

TABLE 3.1.1.1-III

FORWARD SKIRT - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	105	1,240			240	2,894			345	4,069
LAB TECHNICIANS	21	204			48	476			69	670
TOOLING					884	8,800			884	8,595
PRODUCTION										
MANUFACTURING TEST							42	407	42	407
MANUFACTURING TECH.					21	257	1	13	22	264
Q & RA	4	408			224	2,222	11	109	239	2,689
DIRECT DIST					221	1,810	13	130	234	1,899
TRAINING					12	121	1	6	13	124
TOTAL DIRECT LABOR	130	1,852			1,362	16,580	68	664	1,560	18,716
MATERIAL										
LAB. TECHNICIANS		44				101				145
TOOLING						1,110				1,110
PRODUCTION										
MFG. TECHNICIANS						37	2			39
Q & RA		13				67	3			83
SUBTOTAL		57				1,315	5			1,377
MAT. & ADM. BURDEN		19				477	2			498
TOTAL MATERIAL		76				1,792	7			1,875
TOTAL PART II COST		1,928				18,372	671			20,591

MLLV
NON-RECURRING COSTS
PART II FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.1.1.1-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	105,000	1,240,000
1. Laboratory Technicians	<u>21,000</u>	<u>204,120</u>
Subtotal	126,000	1,444,120
2. Q&RA	4,200	408,240
TOTAL ENGINEERING LABOR	<u><u>130,200</u></u>	<u><u>1,852,360</u></u>
 MATERIAL		
3. Laboratory Technicians		44,100
4. Q&RA	<u> </u>	<u>12,600</u>
Subtotal		56,700
5. Material and Adm. Burden		<u>19,278</u>
TOTAL MATERIAL		<u><u>75,978</u></u>
TOTAL ENGINEERING COST		<u><u>1,928,338</u></u>

MLLV
NON-RECURRING COSTS

FORWARD SKIRT
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.1.1-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		239,549	2,894,142
1. Lab. Tech.		<u>47,910</u>	<u>476,394</u>
TOTAL ENGR.		<u>287,459</u>	<u>3,370,536</u>
Fabrication and Erection			
Fab. & Assembly	634,397		6,315,165
Misc. Charges	49,483		492,036
Maintain & Add			
In Scope Changes	<u>6,978</u>		<u>69,389</u>
SUBTOTAL (A)	690,858		6,876,590
2. Tool and Production Planning	<u>193,440</u>		<u>1,923,484</u>
SUBTOTAL (B)	884,298		8,800,074
3. Direct Distributable	<u>221,075</u>		<u>1,809,528</u>
SUBTOTAL (C)	1,105,373		10,609,602
4. Training	<u>12,159</u>		<u>120,904</u>
SUBTOTAL (D)	1,117,532		10,730,506
5. Q&RA	223,506		2,222,449
6. Manufacturing Tech.	<u>21,233</u>		<u>256,530</u>
TOTAL PRODUCTION LABOR	<u>1,362,271</u>		<u>13,209,485</u>
MATERIAL			
7. Tooling			1,110,195
8. Lab. Tech.			100,611
9. Q&RA			67,052
10. Manufacturing Tech.			<u>37,158</u>
MATERIAL SUBTOTAL (E)			1,315,016
11. Material & Adm. Burden			477,105
TOTAL MATERIAL			<u>1,792,121</u>
TOTAL TOOLING COST			<u>17,992,535</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	31,720	308,318
Component Test Planning	<u>10,150</u>	<u>98,662</u>
(1) Subtotal (A)	41,870	406,980
(2) Direct Distributable	<u>13,399</u>	<u>130,233</u>
Subtotal (B)	55,269	537,213
(3) Training	<u>608</u>	<u>5,909</u>
Subtotal (C)	55,877	543,122
(4) Mfg. Tech.	<u>1,062</u>	<u>12,537</u>
Subtotal (D)	56,939	555,659
(5) Q&RA	<u>11,175</u>	<u>108,624</u>
Total Mfg. Test Labor	<u>68,114</u>	<u>664,283</u>
Material		
(6) Q&RA		3,353
(7) Mfg. Tech.		<u>1,858</u>
Subtotal (E)		5,211
(8) Material & Adm. Burden		<u>1,772</u>
Total Material		<u>6,983</u>
Total Mfg. Test Cost		<u>671,266</u>

3.1.1.2 LH_2 Tank

TABLE 3.1.1.2-I
MLLV COST SUMMARY

LH₂ TANK - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	105	1,244								105	1,244
PROGRAM PLAN. & REPT.	263	3,110								263	3,110
INDUSTRIAL RELATIONS	57	554								57	554
ENGINEERING			1,514	17,876						1,514	17,876
LAB TECHNICIANS			303	2,942						303	2,942
TOOLING			5,200	50,544						5,200	50,544
PRODUCTION											
MANUFACTURING TEST			246	2,393						246	2,393
MANUFACTURING TECH.			131	1,548						131	1,549
Q & R A			1,384	13,453						1,384	13,453
FACILITIES											
DIRECT DIST			1,379	13,402						1,379	13,402
TRAINING			76	730						76	730
TOTAL DIRECT LABOR	425	4,908	10,233	102,888						10,657	107,796
MATERIAL		11		7,809							7,820
LOGISTIC HARDWARE											
BURDEN		4		2,654							2,658
TOTAL MATERIAL		15		10,463							10,478
TOTAL OTHER											
TOTAL COST		4,923		113,351							118,274

MLLV

PART I

LH₂ TANK - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	1,514		
Logistics			
Laboratory Technician	303		
Production			
Tooling	5,200		
Manufacturing Test	246		
Q&RA	1,384		
Facilities			
Manufacturing Technician	131		
Total Direct Labor	8,778		
Program Executive		105	1,244
Program Planning & Reporting		263	3,110
Industrial Relations		57	554
Total Labor - Part I		425	4,908
<u>Material</u>			
Program Planning & Reporting			5
Industrial Relations			6
Material Subtotal			11
Material & Administrative Burden			4
Total Material			15
TOTAL COST - PART I			4,923

TABLE 3.1.1.2-III

LH₂ TANK - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	105	1,240			1,409	16,636			1,514	17,876
LAB TECHNICIANS	21	204			282	2,738			303	2,942
TOOLING					5,200	50,544			5,200	50,544
PRODUCTION										
MANUFACTURING TEST							246	2,393	246	2,393
MANUFACTURING TECH.					125	1,475	6	73	131	1,548
Q & RA	4	39			1,314	12,775	66	639	1,384	13,453
DIRECT DIST					1,300	12,636	79	766	1,379	13,402
TRAINING					72	695	4	35	76	730
TOTAL DIRECT LABOR	130	1,483			9,702	97,499	401	3,906	10,233	102,888
MATERIAL										
LAB. TECHNICIANS		44				592				636
TOOLING						6,528				6,528
PRODUCTION										
MFG. TECHNICIANS						219		11		230
Q&RA		1				394		20		415
SUBTOTAL		45				7,733		31		7,809
MAT. & ADM. BURDEN		15				2,629		10		2,654
TOTAL MATERIAL		60				10,362		41		10,463
TOTAL PART II COST		1,543				107,861		3,947		113,351

		MLLV	
		NON-RECURRING COSTS	
PART II		LH ₂ TANK - S/S	
		ASSEMBLY OR SYSTEM	
		DESIGN ENGINEERING	
		TABLE 3.1.1.2-IV	
<u>ELEMENT OF COST</u>		<u>MANHOURS</u>	(IN THOUSANDS) <u>DOLLARS</u>
BASIC DESIGN		105	1,240
1. Laboratory Technicians		<u>21</u>	<u>204</u>
Subtotal		126	1,444
2. Q&RA		4	39
TOTAL ENGINEERING LABOR		<u><u>130</u></u>	<u><u>1,483</u></u>
MATERIAL			
3. Laboratory Technicians			44
4. Q&RA		<u> </u>	<u>1</u>
Subtotal			45
5. Material and Adm. Burden			15
TOTAL MATERIAL			<u><u>60</u></u>
TOTAL ENGINEERING COST			<u><u>1,543</u></u>

MLLV
NON-RECURRING COSTS

LH₂ TANK - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.1.2-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		1,408,642	16,636,062
1. Lab. Tech.		<u>281,728</u>	<u>2,738,400</u>
TOTAL ENGR.		<u>1,690,370</u>	<u>19,374,462</u>
Fabrication and Erection			
Fab. & Assembly	3,730,512		36,260,577
Misc. Charges	290,980		2,828,325
Maintain & Add			
In Scope Changes	<u>41,036</u>		<u>398,866</u>
SUBTOTAL (A)	4,062,528		39,487,768
2. Tool and Production Planning	<u>1,137,508</u>		<u>11,056,575</u>
SUBTOTAL (B)	5,200,036		50,544,343
3. Direct Distributable	<u>1,300,009</u>		<u>12,636,086</u>
SUBTOTAL (C)	6,500,045		63,180,429
4. Training	<u>71,500</u>		<u>694,984</u>
SUBTOTAL (D)	6,571,544		63,875,411
5. Q&RA	1,314,309		12,775,082
6. Manufacturing Tech.	<u>124,859</u>		<u>1,474,588</u>
TOTAL PRODUCTION LABOR	<u>8,010,718</u>		<u>78,125,081</u>
MATERIAL			
7. Tooling			6,528,396
8. Lab. Tech.			591,629
9. Q&RA			394,292
10. Manufacturing Tech.			<u>218,503</u>
MATERIAL SUBTOTAL (E)			7,732,820
11. Material & Adm. Burden			2,629,159
TOTAL MATERIAL			<u>10,361,979</u>
TOTAL TOOLING COST			<u>107,861,522</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

LH₂ TANK - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	186,526	1,813,033
Component Test Planning	<u>59,686</u>	<u>580,170</u>
(1) Subtotal (A)	246,214	2,393,203
(2) Direct Distributable	<u>78,789</u>	<u>765,824</u>
Subtotal (B)	325,003	3,159,027
(3) Training	<u>3,575</u>	<u>34,749</u>
Subtotal (C)	328,578	3,193,776
(4) Mfg. Tech.	<u>6,243</u>	<u>73,729</u>
Subtotal (D)	334,821	3,267,505
(5) Q&RA	<u>65,716</u>	<u>638,755</u>
Total Mfg. Test Labor	<u>400,537</u>	<u>3,906,260</u>
Material		
(6) Q&RA		19,715
(7) Mfg. Tech.		<u>10,925</u>
Subtotal (E)		30,640
(8) Material & Adm. Burden		<u>10,417</u>
Total Material		<u>41,057</u>
Total Mfg. Test Cost		<u>3,947,317</u>

3.1.1.3 LOX Tank

TABLE 3.1.1.3-I
MLLV COST SUMMARY

LOX TANK - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	43	513								43	513
PROGRAM PLAN. & REPT.	109	1,281								109	1,281
INDUSTRIAL RELATIONS	24	228								24	228
ENGINEERING			774	9,140						774	9,140
LAB TECHNICIANS			155	1,504						155	1,504
TOOLING			2,026	19,697						2,026	19,697
PRODUCTION											
MANUFACTURING TEST			96	933						96	933
MANUFACTURING TECH.			51	604						51	604
Q & R A			547	5,314						547	5,314
FACILITIES											
DIRECT DIST			538	5,222						538	5,222
TRAINING			29	285						29	285
TOTAL DIRECT LABOR	176	2,022	4,216	42,699						4,392	44,721
MATERIAL		4		3,122							3,126
LOGISTIC HARDWARE											
BURDEN		2		1,062							1,064
TOTAL MATERIAL		6		4,184							4,190
TOTAL OTHER											
TOTAL COST		2,028		46,883							48,911

MLLV

PART I

LOX TANK - S/S

ASSEMBLY OR SYSTEM

TABLE 3.1.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	744		
Logistics			
Laboratory Technician	155		
Production			
Tooling	2,026		
Manufacturing Test	96		
Q&RA	547		
Facilities			
Manufacturing Technician	<u>51</u>		
Total Direct Labor	<u>3,619</u>		
Program Executive		43	513
Program Planning & Reporting		109	1,281
Industrial Relations		<u>24</u>	<u>228</u>
Total Labor - Part I		<u>176</u>	<u>2,022</u>
<u>Material</u>			
Program Planning & Reporting			2
Industrial Relations			2
Material Subtotal			4
Material & Administrative Burden			<u>2</u>
Total Material			<u>6</u>
TOTAL COST - PART I			<u>2,028</u>

TABLE 3.1.1.3-III

LOX TANK - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	225	2,657			549	6,483			774	9,140
LAB TECHNICIANS	45	437			110	1,067			155	1,504
TOOLING					2,026	19,697			2,026	19,697
PRODUCTION										
MANUFACTURING TEST							96	933	96	933
MANUFACTURING TECH.					49	575	2	29	51	604
Q & RA	9	87			512	4,978	26	249	547	5,314
DIRECT DIST					507	4,924	31	298	538	5,222
TRAINING					28	271	1	14	29	285
TOTAL DIRECT LABOR	279	3,182			3,781	37,995	156	1,522	4,216	42,699
MATERIAL										
LAB. TECHNICIANS		94				231				325
TOOLING						2,544				2,544
PRODUCTION										
MFG. TECHNICIANS						85		4		89
Q&RA		3				154		8		165
SUBTOTAL		97				3,013		12		3,122
MAT. & ADM. BURDEN		33				1,025		4		1,062
TOTAL MATERIAL		130				4,038		16		4,184
TOTAL PART II COST		3,312				42,033		1,538		46,883

MLLV
NON-RECURRING COSTS.
PART II LOX TANK - S/S

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.1.1.3-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	225,000	2,657,250
1. Laboratory Technicians	<u>45,000</u>	<u>437,400</u>
Subtotal		
2. Q&RA	9,000	87,480
TOTAL ENGINEERING LABOR	<u>279,000</u>	<u>3,182,130</u>
 MATERIAL		
3. Laboratory Technicians		94,500
4. Q&RA	<u> </u>	<u>2,700</u>
Subtotal		97,200
5. Material and Adm. Burden		<u>33,048</u>
TOTAL MATERIAL		<u>130,248</u>
TOTAL ENGINEERING COST		<u>3,312,378</u>

MLLV
NON-RECURRING COSTS
LOX TANK - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.1.3-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		548,945	6,483,040
1. Lab. Tech.		<u>109,789</u>	<u>1,067,149</u>
TOTAL ENGR.		<u>658,734</u>	<u>7,550,189</u>
Fabrication and Erection			
Fab. & Assembly	1,453,774		14,130,683
Misc. Charges	113,394		1,102,193
Maintain & Add			
In Scope Changes	<u>15,992</u>		<u>155,437</u>
SUBTOTAL (A)	1,583,160		15,388,313
2. Tool and Production Planning	<u>443,285</u>		<u>4,308,727</u>
SUBTOTAL (B)	2,026,445		19,697,040
3. Direct Distributable	<u>506,611</u>		<u>4,924,260</u>
SUBTOTAL (C)	2,533,056		24,621,300
4. Training	<u>27,864</u>		<u>270,834</u>
SUBTOTAL (D)	2,560,919		24,892,134
5. Q&RA	512,184		4,978,427
6. Manufacturing Tech.	<u>48,657</u>		<u>574,644</u>
TOTAL PRODUCTION LABOR	<u>3,121,760</u>		<u>30,445,205</u>
MATERIAL			
7. Tooling			2,544,105
8. Lab. Tech.			230,557
9. Q&RA			153,655
10. Manufacturing Tech.			<u>85,150</u>
MATERIAL SUBTOTAL (E)			3,013,467
11. Material & Adm. Burden			<u>1,024,579</u>
TOTAL MATERIAL			<u>4,038,046</u>
TOTAL TOOLING COST			<u>42,033,440</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
LOX TANK - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 3.1.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	72,689	706,537
Component Test Planning	<u>23,260</u>	<u>226,091</u>
(1) Subtotal (A)	95,949	932,628
(2) Direct Distributable	<u>30,704</u>	<u>298,441</u>
Subtotal (B)	126,653	1,231,069
(3) Training	<u>1,393</u>	<u>13,541</u>
Subtotal (C)	128,046	1,244,610
(4) Mfg. Tech.	<u>2,433</u>	<u>28,731</u>
Subtotal (D)	130,479	1,273,341
(5) Q&RA	<u>25,609</u>	<u>248,921</u>
Total Mfg. Test Labor	<u>156,088</u>	<u>1,522,262</u>
Material		
(6) Q&RA		7,683
(7) Mfg. Tech.		<u>4,257</u>
Subtotal (E)		11,940
(8) Material & Adm. Burden		<u>4,060</u>
Total Material		<u>16,000</u>
Total Mfg. Test Cost		<u>1,538,262</u>

3.1.1.4 Tunnels

TABLE 3.1.1.4-I
MLLV COST SUMMARY

TUNNELS - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	8	99								8	99
PROGRAM PLAN. & REPT.	21	249								21	249
INDUSTRIAL RELATIONS	5	44								5	44
ENGINEERING			186	2,203						186	2,203
LAB TECHNICIANS			37	363						37	363
TOOLING			356	3,462						356	3,462
PRODUCTION											
MANUFACTURING TEST			17	164						17	164
MANUFACTURING TECH.			9	106						9	106
Q & R A			99	958						99	958
FACILITIES											
DIRECT DIST			94	918						94	918
TRAINING			5	49						5	49
TOTAL DIRECT LAECR	34	392	803	8,223						837	8,615
MATERIAL		1		571							572
LOGISTIC HARDWARE											
BURDEN				194							194
TOTAL MATERIAL		1		765							766
TOTAL OTHER											
TOTAL COST		393		8,988							9,381

MLLV

PART I

TUNNELS - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	186		
Logistics			
Laboratory Technician	37		
Production			
Tooling	356		
Manufacturing Test	17		
Q&RA	99		
Facilities			
Manufacturing Technician	<u>9</u>		
Total Direct Labor	<u>704</u>		
Program Executive		8	99
Program Planning & Reporting		21	249
Industrial Relations		<u>5</u>	<u>44</u>
Total Labor - Part I		<u>34</u>	<u>392</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			<u> </u>
Total Material			<u>1</u>
TOTAL COST - PART I			<u>393</u>

TABLE 3.1.1.4-III

TUNNELS - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	90	1,063			96	1,140			186	2,203
LAB TECHNICIANS	18	175			19	188			37	363
TOOLING					356	3,462			356	3,462
PRODUCTION										
MANUFACTURING TEST							17	164	17	164
MANUFACTURING TECH.					9	101		5	9	106
Q & RA	4	39			90	875	5	44	99	958
DIRECT DIST					89	865	5	53	94	918
TRAINING					5	47		2	5	49
TOTAL DIRECT LABOR	112	1,277			664	6,678	27	268	803	8,223
MATERIAL										
LAB. TECHNICIANS		38				41				79
TOOLING						447				447
PRODUCTION										
MFG. TECHNICIANS						15		1		16
Q&RA		1				27		1		29
SUBTOTAL		39				530		2		571
MAT. & ADM. BURDEN		13				180		1		194
TOTAL MATERIAL		52				710		3		765
TOTAL PART II COST		1,329				7,388		271		8,988

MLLV
NON-RECURRING COSTS

PART II TUNNELS - S/S

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.1.1.4-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	90	1,063
1. Laboratory Technicians	<u>18</u>	<u>175</u>
Subtotal	108	1,238
2. Q&RA	4	39
TOTAL ENGINEERING LABOR	<u><u>112</u></u>	<u><u>1,277</u></u>
MATERIAL		
3. Laboratory Technicians		38
4. Q&RA	<u> </u>	<u>1</u>
Subtotal		39
5. Material and Adm. Burden		13
TOTAL MATERIAL		<u><u>52</u></u>
TOTAL ENGINEERING COST		<u><u>1,329</u></u>

MLIV
NON-RECURRING COSTS

TUNNELS - S/S

PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.1.4-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		96,488	1,139,523
1. Lab. Tech.		<u>19,298</u>	<u>187,573</u>
TOTAL ENGR.		<u>115,786</u>	<u>1,327,096</u>
Fabrication and Erection			
Fab. & Assembly	255,528		2,483,732
Misc. Charges	19,931		193,730
Maintain & Add			
In Scope Changes	<u>2,811</u>		<u>27,321</u>
SUBTOTAL (A)	278,270		2,704,783
2. Tool and Production Planning	<u>77,916</u>		<u>757,339</u>
SUBTOTAL (B)	356,186		3,462,122
3. Direct Distributable	<u>89,046</u>		<u>865,530</u>
SUBTOTAL (C)	445,232		4,327,652
4. Training	<u>4,898</u>		<u>47,604</u>
SUBTOTAL (D)	450,130		4,375,256
5. Q&RA	90,026		875,051
6. Manufacturing Tech.	<u>8,552</u>		<u>101,004</u>
TOTAL PRODUCTION LABOR	<u>548,708</u>		<u>5,351,311</u>
MATERIAL			
7. Tooling			447,174
8. Lab. Tech.			40,526
9. Q&RA			27,007
10. Manufacturing Tech.			<u>14,966</u>
MATERIAL SUBTOTAL (E)			529,673
11. Material & Adm. Burden			180,089
TOTAL MATERIAL			<u>709,762</u>
TOTAL TOOLING COST			<u>7,388,169</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
TUNNELS - TOOLING - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 3.1.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	12,776	124,183
Component Test Planning	<u>4,088</u>	<u>39,738</u>
(1) Subtotal (A)	16,864	163,921
(2) Direct Distributable	<u>5,397</u>	<u>52,454</u>
Subtotal (B)	22,261	216,375
(3) Training	<u>245</u>	<u>2,379</u>
Subtotal (C)	22,506	218,754
(4) Mfg. Tech.	<u>428</u>	<u>5,050</u>
Subtotal (D)	22,934	223,804
(5) Q&RA	<u>4,501</u>	<u>43,751</u>
Total Mfg. Test Labor	<u>27,435</u>	<u>267,555</u>
Material		
(6) Q&RA		1,350
(7) Mfg. Tech.		<u>748</u>
Subtotal (E)		2,098
(8) Material & Adm. Burden		<u>714</u>
Total Material		<u>2,812</u>
Total Mfg. Test Cost		<u>270,367</u>

3.1.1.5 Thrust Structure

TABLE 3.1.1.5-I
MLLV COST SUMMARY

THRUST STRUCTURE - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	18	211								18	211
PROGRAM PLAN. & REPT.	45	529								45	529
INDUSTRIAL RELATIONS	10	94								10	94
ENGINEERING			423	4,997						423	4,997
LAB TECHNICIANS			85	822						85	822
TOOLING			731	7,108						731	7,108
PRODUCTION											
MANUFACTURING TEST			35	337						35	337
MANUFACTURING TECH.			19	217						19	217
Q & R A			203	1,974						203	1,974
FACILITIES											
DIRECT DIST			194	1,885						194	1,885
TRAINING			11	103						11	103
TOTAL DIRECT LAEOR	73	834	1,701	17,443						1,174	18,277
MATERIAL		2		1,188							1,190
LOGISTIC HARDWARE											
BURDEN		1		405							406
TOTAL MATERIAL		3		1,593							1,596
TOTAL OTHER											
TOTAL COST		837		19,036							19,873

MLLV

PART I

THRUST STRUCTURE - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.1.5-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	423		
Logistics			
Laboratory Technician	85		
Production			
Tooling	731		
Manufacturing Test	35		
Q&RA	203		
Facilities			
Manufacturing Technician	19		
Total Direct Labor	<u>1,496</u>		
Program Executive		18	211
Program Planning & Reporting		45	529
Industrial Relations		10	94
Total Labor - Part I		<u>73</u>	<u>834</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			1
Total Material			<u>3</u>
TOTAL COST - PART I			<u>837</u>

TABLE 3.1.1.5-III

THRUST STRUCTURE - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	225	2,657			198	2,340			423	4,997
LAB TECHNICIANS	45	437			40	385			85	822
TOOLING					731	7,108			731	7,108
PRODUCTION										
MANUFACTURING TEST							35	337	35	337
MANUFACTURING TECH.					18	207	1	10	19	217
Q & RA	9	87			185	1,797	9	90	203	1,974
DIRECT DIST					183	1,777	11	108	194	1,885
TRAINING					10	98	1	5	11	103
TOTAL DIRECT LABOR	279	3,182			1,365	13,712	56	549	1,700	17,443
MATERIAL										
LAB. TECHNICIANS		94				83				177
TOOLING						918				918
PRODUCTION										
MFG. TECHNICIANS						30		1		31
Q&RA		3				55		3		61
SUBTOTAL		97				1,087		4		1,188
MAT. & ADM. BURDEN		33				370		2		405
TOTAL MATERIAL		130				1,457		6		1,593
TOTAL PART II COST		3,312				15,169		555		19,036

MLLV
NON-RECURRING COSTS

PART II THRUST STRUCTURE - S/S

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.1.1.5-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	225,000	2,657,250
1. Laboratory Technicians	<u>45,000</u>	<u>437,400</u>
Subtotal		
2. Q&RA	9,000	87,480
TOTAL ENGINEERING LABOR	<u>279,000</u>	<u>3,182,130</u>
MATERIAL		
3. Laboratory Technicians		94,500
4. Q&RA	<u> </u>	<u>2,700</u>
Subtotal		97,200
5. Material and Adm. Burden		<u>33,048</u>
TOTAL MATERIAL		<u>130,248</u>
TOTAL ENGINEERING COST		<u>3,312,378</u>

MLLV
NON-RECURRING COSTS
THRUST STRUCTURE - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.1.5-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		198,109	2,339,667
1. Lab. Tech.		<u>39,622</u>	<u>385,124</u>
TOTAL ENGR.		<u>237,731</u>	<u>2,724,791</u>
Fabrication and Erection			
Fab. & Assembly	524,651		5,099,608
Misc. Charges	40,923		397,769
Maintain & Add In Scope Changes	<u>5,771</u>		<u>56,095</u>
SUBTOTAL (A)	571,345		1,554,972
2. Tool and Production Planning	<u>159,977</u>		<u>1,554,972</u>
SUBTOTAL (B)	731,322		7,108,442
3. Direct Distributable	<u>182,830</u>		<u>1,777,111</u>
SUBTOTAL (C)	914,152		8,885,553
4. Training	<u>10,056</u>		<u>97,740</u>
SUBTOTAL (D)	924,208		8,983,293
5. Q&RA	184,841		1,796,658
6. Manufacturing Tech.	<u>17,560</u>		<u>207,382</u>
TOTAL PRODUCTION LABOR	<u>1,126,609</u>		<u>10,987,333</u>
MATERIAL			
7. Tooling			918,139
8. Lab. Tech.			83,206
9. Q&RA			55,452
10. Manufacturing Tech.			<u>30,730</u>
MATERIAL SUBTOTAL (E)			1,087,527
11. Material & Adm. Burden			369,759
TOTAL MATERIAL			<u>1,457,286</u>
TOTAL TOOLING COST			<u>15,169,410</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

THRUST STRUCTURE - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.1.5-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	26,233	254,985
Component Test Planning	<u>8,395</u>	<u>81,595</u>
(1) Subtotal (A)	34,628	336,580
(2) Direct Distributable	<u>11,081</u>	<u>107,705</u>
Subtotal (B)	45,709	444,285
(3) Training	<u>503</u>	<u>4,886</u>
Subtotal (C)	46,212	449,171
(4) Mfg. Tech.	<u>878</u>	<u>10,369</u>
Subtotal (D)	47,090	459,540
(5) Q&RA	<u>9,242</u>	<u>89,834</u>
Total Mfg. Test Labor	<u>56,332</u>	<u>549,374</u>
Material		
(6) Q&RA		2,773
(7) Mfg. Tech.		<u>1,537</u>
Subtotal (E)		4,310
(8) Material & Adm. Burden		<u>1,465</u>
Total Material		<u>5,775</u>
Total Mfg. Test Cost		<u>555,149</u>

3.1.1.6 Base Plug

BASE PLUG - SINGLE STAGE

TABLE 3.1.1.6-I

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	13	151	-	-						13	151
PROGRAM PLAN. & REPT.	32	378	-	-						32	378
INDUSTRIAL RELATIONS	7	67	-	-						7	67
ENGINEERING	-	-	473	5,590						473	5,590
LAB TECHNICIANS	-	-	95	920						95	920
TOOLING	-	-	363	3,529						363	3,529
PRODUCTION	-	-	-	-						-	-
MANUFACTURING TEST	-	-	17	167						17	167
MANUFACTURING TECH.	-	-	9	108						9	108
Q & R A	-	-	112	1,083						112	1,083
FACILITIES	-	-	-	-						-	-
DIRECT DIST	-	-	97	935						97	935
TRAINING	-	-	5	51						5	51
TOTAL DIRECT LABOR	52	596	1,171	12,383						1,223	12,979
MATERIAL		2		704							706
LOGISTIC HARDWARE		-		-							-
BURDEN		-		240							240
TOTAL MATERIAL		2		944							946
TOTAL OTHER		-		-							-
TOTAL COST		598		13,327							\$13,925

MLLV

PART I

BASE PLUG - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.1.6-II

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	473		
Logistics			
Laboratory Technician	95		
Production			
Tooling	363		
Manufacturing Test	17		
Q&RA	112		
Facilities			
Manufacturing Technician	<u>9</u>		
Total Direct Labor	<u>1,069</u>		
Program Executive		13	151
Program Planning & Reporting		32	378
Industrial Relations		<u>7</u>	<u>67</u>
Total Labor - Part I		<u>52</u>	<u>\$596</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			
Total Material			<u>2</u>
TOTAL COST - PART I			<u>\$598</u>

BASE PLUG - SINGLE STAGE

TABLE 3.1.1.6-III

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	375	4,429			98	1,161			473	5,590
LAB TECHNICIANS	75	729			20	191			95	920
TOOLING					363	3,529			363	3,529
PRODUCTION										
MANUFACTURING TEST							17	167	17	167
MANUFACTURING TECH.					9	103		5	9	108
Q & RA	15	146			92	892	5	45	112	1,083
DIRECT DIST					91	882	6	53	97	935
TRAINING					5	49		2	5	51
TOTAL DIRECT LABOR	465	5,304			677	6,806	28	273	1,170	12,383
MATERIAL										
LAB. TECHNICIANS		157				41				198
TOOLING						456				456
PRODUCTION										
MFG. TECHNICIANS						15		1		16
Q&RA		5				18		1		34
SUBTOTAL		162				540		2		704
MAT. & ADM. BURDEN		55				184		1		240
TOTAL MATERIAL		217				724		3		944
TOTAL PART II COST		\$5,521				\$7,530		\$276		\$13,327

MLLV			
NON-RECURRING COSTS			
PART II		<u>BASE PLUG - S/S</u>	
ASSEMBLY OR SYSTEM			
DESIGN ENGINEERING			
TABLE 3.1.1.6-IV			
<u>ELEMENT OF COST</u>		<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		375,000	\$4,428,750
1. Laboratory Technicians		<u>75,000</u>	<u>729,000</u>
Subtotal			
2. Q&RA		15,000	145,800
TOTAL ENGINEERING LABOR		<u>465,000</u>	<u>\$5,303,550</u>
MATERIAL			
3. Laboratory Technicians			157,500
4. Q&RA		<u> </u>	<u>4,500</u>
Subtotal			162,500
5. Material and Adm. Burden			<u>55,250</u>
TOTAL MATERIAL			<u>217,250</u>
TOTAL ENGINEERING COST			<u>\$5,520,800</u>

MLLV
NON-RECURRING COSTS

BASE PLUG - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING
TABLE 3.1.1.6-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		98,280	\$1,160,687
1. Lab. Tech.		<u>19,656</u>	<u>191,056</u>
TOTAL ENGR.		<u>117,936</u>	<u>\$1,351,743</u>
Fabrication and Erection			
Fab. & Assembly	260,442		2,531,496
Misc. Charges	20,314		197,456
Maintain & Add In Scope Changes	<u>2,865</u>		<u>27,846</u>
SUBTOTAL (A)	283,621		2,756,798
2. Tool and Production Planning	<u>79,414</u>		<u>771,903</u>
SUBTOTAL (B)	363,035		3,528,701
3. Direct Distributable	<u>90,759</u>		<u>882,175</u>
SUBTOTAL (C)	453,794		4,410,876
4. Training	<u>4,992</u>		<u>48,519</u>
SUBTOTAL (D)	458,786		4,459,395
5. Q&RA	91,757		891,879
6. Manufacturing Tech.	<u>8,717</u>		<u>102,947</u>
TOTAL PRODUCTION LABOR	<u>559,260</u>		<u>\$5,454,221</u>
MATERIAL			
7. Tooling			455,774
8. Lab. Tech.			41,228
9. Q&RA			27,527
10. Manufacturing Tech.			<u>15,253</u>
MATERIAL SUBTOTAL (E)			539,832
11. Material & Adm. Burden			183,543
TOTAL MATERIAL			<u>723,375</u>
TOTAL TOOLING COST			<u>\$7,529,339</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

BASE PLUG - TOOLING S/S

ASSEMBLY OR SYSTEM

TABLE 3.1.1.6-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	13,022	\$126,574
Component Test Planning	<u>4,167</u>	<u>40,503</u>
(1) Subtotal (A)	17,189	167,077
(2) Direct Distributable	<u>5,500</u>	<u>53,464</u>
Subtotal (B)	22,689	220,541
(3) Training	<u>250</u>	<u>2,425</u>
Subtotal (C)	22,939	222,966
(4) Mfg. Tech.	<u>436</u>	<u>5,147</u>
Subtotal (D)	23,375	228,113
(5) Q&RA	<u>4,588</u>	<u>44,592</u>
Total Mfg. Test Labor	<u>27,963</u>	<u>\$272,705</u>
Material		
(6) Q&RA		1,376
(7) Mfg. Tech.		<u>763</u>
Subtotal (E)		2,139
(8) Material & Adm. Burden		<u>727</u>
Total Material		<u>2,866</u>
Total Mfg. Test Cost		<u>\$275,571</u>

3.1.1.7 Structure Assembly

TABLE 3.1.1.7-I

STRUCTURE ASSEMBLY - S/S

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	13								1	13
PROGRAM PLAN. & REPT.	3	32								3	32
INDUSTRIAL RELATIONS	1	6								1	6
ENGINEERING			75	886						75	886
LAB TECHNICIANS			15	146						15	146
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			3	29						3	29
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	5	51	93	1,061						98	1,112
MATERIAL				33							33
LOGISTIC HARDWARE											
BURDEN				11							11
TOTAL MATERIAL				44							44
TOTAL OTHER											
TOTAL COST		51		1,105							1,156

MLLV

PART I

STRUCTURE ASSEMBLY - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.1.7-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	75		
Logistics			
Laboratory Technician	15		
Production			
Tooling			
Manufacturing Test			
Q&RA	3		
Facilities			
Manufacturing Technician			
	<u> </u>		
Total Direct Labor	<u>93</u>		
Program Executive		1	13
Program Planning & Reporting		3	32
Industrial Relations		1	6
		<u> </u>	<u> </u>
Total Labor - Part I		<u>5</u>	<u>51</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			<u> </u>
Total Material			<u> </u>
TOTAL COST - PART I			<u>51</u>

TABLE 3.1.1.7-III

STRUCTURE ASSEMBLY - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	75	886							75	886
LAB TECHNICIANS	15	146							15	146
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & RA	3	29							3	29
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	93	1,061							93	1,061
MATERIAL										
LAB. TECHNICIANS		32								32
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q&RA		1								1
SUBTOTAL		33								33
MAT. & ADM. BURDEN		11								11
TOTAL MATERIAL		44								44
TOTAL PART II COST		1,105								1,105

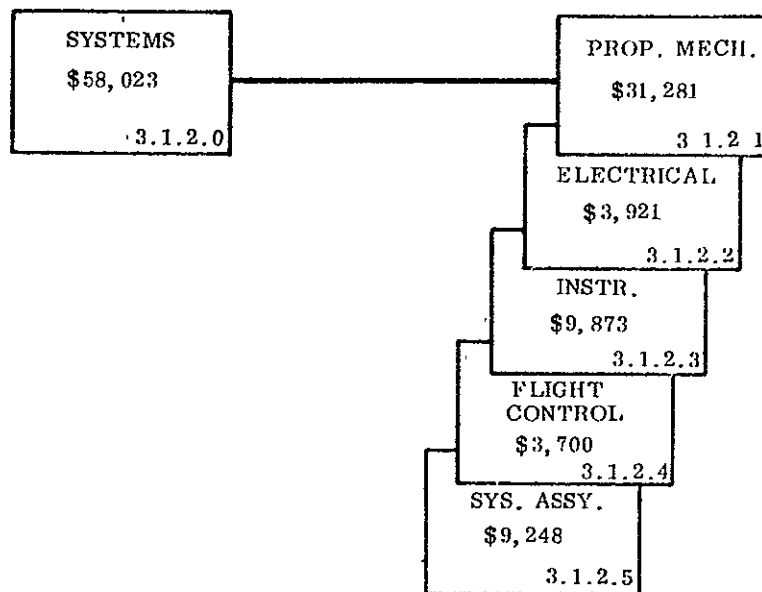
MLLV		
NON-RECURRING COSTS		
PART II	<u>STRUCTURES ASSEMBLY - S/S</u>	
	ASSEMBLY OR SYSTEM	
	DESIGN ENGINEERING	
	TABLE 3.1.1.7-IV	
<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	(IN THOUSANDS) <u>DOLLARS</u>
BASIC DESIGN	75	886
1. Laboratory Technicians	<u>15</u>	<u>146</u>
Subtotal	90	1,032
2. Q&RA	3	29
TOTAL ENGINEERING LABOR	<u><u>93</u></u>	<u><u>1,061</u></u>
MATERIAL		
3. Laboratory Technicians		32
4. Q&RA	<u> </u>	<u>1</u>
Subtotal		33
5. Material and Adm. Burden		<u>11</u>
TOTAL MATERIAL		<u><u>44</u></u>
TOTAL ENGINEERING COST		<u><u>1,105</u></u>

3.1.2 Systems

The Get Ready Costs for the system components of the single stage vehicle are displayed in Figure 3.1.2.0-1. The details for each individual system component are contained in the appropriate subparagraph, as indicated in the figure.

Table 3.1.2.0-I is a total Get Ready Cost of all of the systems.

These costs consist of basic (or non-recurring) engineering required to produce the basic tooling, fabrication and assembly of tooling, and basic article design including all engineering, such as, manufacturing liaison and coordination required to produce the first article. These costs are non-recurring in that they are experienced once during the production cycle.



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.1.2.0-1 MLLV MAIN STAGE SYSTEMS COSTS GET READY, "A" COSTS

TABLE 3.1.2.0-I

SYSTEMS - SINGLE STAGE

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	53	633								53	633
PROGRAM PLAN. & REPT.	135	1,587								135	1,587
INDUSTRIAL RELATIONS	29	282								29	282
ENGINEERING			2,264	26,729						2,264	26,729
LAB TECHNICIANS			453	4,399						453	4,399
TOOLING			1,267	12,317						1,267	12,317
PRODUCTION											
MANUFACTURING TEST			60	583						60	583
MANUFACTURING TECH.			32	377						32	377
Q & R A			412	4,018						412	4,018
FACILITIES											
DIRECT DIST			337	3,265						337	3,265
TRAINING			18	179						18	179
TOTAL DIRECT LABOR	217	2,502	4,843	51,867						5,060	54,369
MATERIAL		5		2,723							2,728
LOGISTIC HARDWARE											
BURDEN		1		925							926
TOTAL MATERIAL		6		3,648							3,654
TOTAL OTHER											
TOTAL COST		2,508		55,515							58,023

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3.1.2.1 Propulsion/Mechanical System

TABLE 3.1.2.1-I
MLLV COST SUMMARY

PROPULSION AND MECHANICAL - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	28	333								28	333
PROGRAM PLAN. & REPT.	71	834								71	834
INDUSTRIAL RELATIONS	15	148								15	148
ENGINEERING			683	8,065						683	8,065
LAB TECHNICIANS			137	1,328						137	1,328
TOOLING			1,137	11,048						1,137	11,048
PRODUCTION											
MANUFACTURING TEST			54	523						54	523
MANUFACTURING TECH.			28	338						28	338
Q & R A			316	3,079						316	3,079
FACILITIES											
DIRECT DIST			301	2,929						301	2,929
TRAINING			17	160						17	160
TOTAL DIRECT LABOR	114	1,315	2,673	27,470						2,787	28,785
MATERIAL		3		1,860							1,863
LOGISTIC HARDWARE											
BURDEN		1		632							633
TOTAL MATERIAL		4		2,492							2,492
TOTAL OTHER											
TOTAL COST		1,319		29,962							31,281

MLLV

PART I

PROPULSION AND MECHANICAL - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.2.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	683		
Logistics			
Laboratory Technician	137		
Production			
Tooling	1,137		
Manufacturing Test	54		
Q&RA	316		
Facilities			
Manufacturing Technician	28		
Total Direct Labor	<u>2,355</u>		
Program Executive		28	333
Program Planning & Reporting		71	834
Industrial Relations		15	148
Total Labor - Part I		<u>114</u>	<u>1,315</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			2
Material Subtotal			3
Material & Administrative Burden			1
Total Material			<u>4</u>
TOTAL COST - PART I			<u>1,319</u>

TABLE 3.1.2.1-III

PROPULSION AND MECHANICAL - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	375	4,429			308	3,636			683	8,065
LAB TECHNICIANS	75	729			62	599			137	1,328
TOOLING					1,137	11,048			1,137	11,048
PRODUCTION										
MANUFACTURING TEST							54	523	54	523
MANUFACTURING TECH.					27	322	1	16	28	338
Q&RA	15	146			287	2,793	14	140	316	3,079
DIRECT DIST					284	2,762	17	167	301	2,929
TRAINING					16	152	1	8	17	160
TOTAL DIRECT LABOR	465	5,304			2,120	21,312	88	854	2,673	27,470
MATERIAL										
LAB. TECHNICIANS		158				129				287
TOOLING						1,427				1,427
PRODUCTION										
MFG. TECHNICIANS						48		3		51
Q&RA		5				86		4		95
SUBTOTAL		163				1,690		7		1,860
MAT. & ADM. BURDEN		55				575		2		632
TOTAL MATERIAL		218				2,265		9		2,492
TOTAL PART II COST		5,522				23,577		863		29,962

MLLV
NON-RECURRING COSTS
PART II PROPULSION AND MECHANICAL SYSTEM - S/S
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.1.2.1-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		375	4,429
1. Laboratory Technicians		<u>75</u>	<u>729</u>
Subtotal		450	5,158
2. Q&RA		15	146
TOTAL ENGINEERING LABOR		<u>465</u>	<u>5,304</u>
MATERIAL			
3. Laboratory Technicians			158
4. Q&RA		<u> </u>	<u>5</u>
Subtotal			163
5. Material and Adm. Burden			55
TOTAL MATERIAL			<u>218</u>
TOTAL ENGINEERING COST			<u>5,522</u>

MLLV
NON-RECURRING COSTS
PROPULSION AND MECHANICAL SYSTEM - S/S

PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.2.1-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		307,913	3,636,453
1. Lab. Tech.		<u>61,583</u>	<u>598,583</u>
TOTAL ENGR.		<u>369,496</u>	<u>4,235,036</u>
Fabrication and Erection			
Fab. & Assembly	815,446		7,926,135
Misc. Charges	63,605		618,238
Maintain & Add			
In Scope Changes	<u>8,970</u>		<u>87,187</u>
SUBTOTAL (A)	888,021		8,631,560
2. Tool and Production Planning	<u>248,646</u>		<u>2,416,836</u>
SUBTOTAL (B)	1,136,667		11,048,396
3. Direct Distributable	<u>284,167</u>		<u>2,762,098</u>
SUBTOTAL (C)	1,420,834		13,810,494
4. Training	<u>15,629</u>		<u>151,915</u>
SUBTOTAL (D)	1,436,463		13,962,409
5. Q&RA	287,292		2,792,481
6. Manufacturing Tech.	<u>27,293</u>		<u>322,327</u>
TOTAL PRODUCTION LABOR	<u>1,751,048</u>		<u>17,077,217</u>
MATERIAL			
7. Tooling			1,427,030
8. Lab. Tech.			129,324
9. Q&RA			86,188
10. Manufacturing Tech.			<u>47,763</u>
MATERIAL SUBTOTAL (E)			1,690,305
11. Material & Adm. Burden			574,704
TOTAL MATERIAL			<u>2,265,009</u>
TOTAL TOOLING COST			<u>23,577,262</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
PROPULSION AND MECHANICAL - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.2.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	40,772	396,304
Component Test Planning	13,047	126,817
(1) Subtotal (A)	53,819	523,121
(2) Direct Distributable	17,222	167,398
Subtotal (B)	71,041	690,519
(3) Training	781	7,595
Subtotal (C)	71,822	698,114
(4) Mfg. Tech.	1,365	16,116
Subtotal (D)	73,187	714,230
(5) Q&RA	14,364	139,622
Total Mfg. Test Labor	<u>87,551</u>	<u>853,852</u>
Material		
(6) Q&RA		4,309
(7) Mfg. Tech.		2,388
Subtotal (E)		6,697
(8) Material & Adm. Burden		2,277
Total Material		<u>8,974</u>
Total Mfg. Test Cost		<u>862,826</u>

3.1.2.2 Electrical System

TABLE 3.1.2.2-I
MLLV COST SUMMARY

ELECTRICAL - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	44								4	44
PROGRAM PLAN. & REPT.	9	110								9	110
INDUSTRIAL RELATIONS	2	19								2	19
ENGINEERING			231	2,722						231	2,722
LAB TECHNICIANS			46	448						46	448
TOOLING			20	197						20	197
PRODUCTION											
MANUFACTURING TEST			1	9						1	9
MANUFACTURING TECH.			1	6						1	6
Q & R A			14	140						14	140
FACILITIES											
DIRECT DIST			6	52						6	52
TRAINING				3							3
TOTAL DIRECT LAECR	15	173	319	3,577						334	3,750
MATERIAL				128							128
LOGISTIC HARDWARE											
BURDEN				43							43
TOTAL MATERIAL				171							171
TOTAL OTHER											
TOTAL COST		173		3,748							3,921

MLLV

PART I

ELECTRICAL - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.2.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	231		
Logistics			
Laboratory Technician	46		
Production			
Tooling	20		
Manufacturing Test	1		
Q&RA	14		
Facilities			
Manufacturing Technician	1		
Total Direct Labor	<u>313</u>		
Program Executive		4	44
Program Planning & Reporting		9	110
Industrial Relations		2	19
Total Labor - Part I		<u>15</u>	<u>173</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>173</u>

TABLE 3.1.2.2-III
MLLV PART II COST SUMMARY

ELECTRICAL - SINGLE STAGE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	225	2,657			6	65			231	2,722
LAB TECHNICIANS	45	437			1	11			56	448
TOOLING					20	197			20	197
PRODUCTION										
MANUFACTURING TEST							1	9	1	9
MANUFACTURING TECH.					1	6			1	6
Q&RA	9	87			5	50		3	14	140
DIRECT DIST					5	49	1	3	6	52
TRAINING						3				3
TOTAL DIRECT LABOR	279	3,181			38	381	2	15	319	3,577
MATERIAL										
LAB. TECHNICIANS		95				2				97
TOOLING						25				25
PRODUCTION										
MFG. TECHNICIANS						1				1
Q&RA		3				2				5
SUBTOTAL		98				30				128
MAT. & ADM. BURDEN		33				10				43
TOTAL MATERIAL		131				40				171
TOTAL PART II COST		3,312				421		15		3,748

MLLV
NON-RECURRING COSTS
PART II ELECTRICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.1.2.2-IV	<u>MANHOURS</u>	(IN THOUSANDS) <u>DOLLARS</u>
BASIC DESIGN		225	2,657
1. Laboratory Technicians		<u>45</u>	<u>437</u>
Subtotal		270	3,094
2. Q&RA		9	87
TOTAL ENGINEERING LABOR		<u>279</u>	<u>3,181</u>
MATERIAL			
3. Laboratory Technicians			95
4. Q&RA		<u> </u>	<u>3</u>
Subtotal			98
5. Material and Adm. Burden			<u>33</u>
TOTAL MATERIAL			<u>131</u>
TOTAL ENGINEERING COST			<u>3,312</u>

MLLV
NON-RECURRING COSTS
ELECTRICAL SYSTEM - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.2.2-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		5,492	64,861
1. Lab. Tech.		<u>1,098</u>	<u>10,676</u>
TOTAL ENGR.		<u>6,590</u>	<u>75,537</u>
Fabrication and Erection			
Fab. & Assembly	14,545		141,377
Misc. Charges	1,135		11,027
Maintain & Add In Scope Changes	<u>160</u>		<u>1,554</u>
SUBTOTAL (A)	15,840		153,958
2. Tool and Production Planning	<u>4,435</u>		<u>43,108</u>
SUBTOTAL (B)	20,275		197,066
3. Direct Distributable	<u>5,069</u>		<u>59,267</u>
SUBTOTAL (C)	25,344		246,333
4. Training	<u>279</u>		<u>2,709</u>
SUBTOTAL (D)	25,623		249,042
5. Q&RA	5,124		49,808
6. Manufacturing Tech.	<u>487</u>		<u>5,749</u>
TOTAL PRODUCTION LABOR	<u>31,234</u>		<u>304,599</u>
MATERIAL			
7. Tooling			25,455
8. Lab. Tech.			2,306
9. Q&RA			1,537
10. Manufacturing Tech.			<u>852</u>
MATERIAL SUBTOTAL (E)			30,150
11. Material & Adm. Burden			10,251
TOTAL MATERIAL			<u>40,401</u>
TOTAL TOOLING COST			<u>420,537</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

ELECTRICAL SYSTEMS - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.2.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	727	7,066
Component Test Planning	<u>233</u>	<u>2,261</u>
(1) Subtotal (A)	960	9,327
(2) Direct Distributable	<u>307</u>	<u>2,984</u>
Subtotal (B)	1,267	12,311
(3) Training	<u>14</u>	<u>135</u>
Subtotal (C)	1,281	12,446
(4) Mfg. Tech.	<u>24</u>	<u>287</u>
Subtotal (D)	1,305	12,733
(5) Q&RA	<u>256</u>	<u>2,489</u>
Total Mfg. Test Labor	<u><u>1,561</u></u>	<u><u>15,222</u></u>
Material		
(6) Q&RA		77
(7) Mfg. Tech.		<u>43</u>
Subtotal (E)		120
(8) Material & Adm. Burden		<u>41</u>
Total Material		<u><u>161</u></u>
Total Mfg. Test Cost		<u><u>15,383</u></u>

3.1.2.3 Instrumentation System

TABLE 3.1.2.3-I
MLLV COST SUMMARY

INSTRUMENTATION - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	9	111								9	111
PROGRAM PLAN. & REPT.	24	280								24	280
INDUSTRIAL RELATIONS	5	50								5	50
ENGINEERING			608	7,175						608	7,175
LAB TECHNICIANS			122	1,181						122	1,181
TOOLING			28	271						28	271
PRODUCTION											
MANUFACTURING TEST			1	13						1	13
MANUFACTURING TECH.			1	8						1	8
Q & R A			31	305						31	305
FACILITIES											
DIRECT DIST			8	72						8	72
TRAINING				4							4
TOTAL DIRECT LABOR	38	441	799	9,029						837	9,470
MATERIAL		1		300							301
LOGISTIC HARDWARE											
BURDEN				102							102
TOTAL MATERIAL		1		402							403
TOTAL OTHER											
TOTAL COST		442		9,431							9,873

MLLV

PART I

INSTRUMENTATION - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.2.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	608		
Logistics			
Laboratory Technician	122		
Production			
Tooling	28		
Manufacturing Test	1		
Q&RA	31		
Facilities			
Manufacturing Technician	1		
Total Direct Labor	<u>791</u>		
Program Executive		9	111
Program Planning & Reporting		24	280
Industrial Relations		<u>5</u>	<u>50</u>
Total Labor - Part I		<u>38</u>	<u>441</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			1
Material Subtotal			
Material & Administrative Burden			
Total Material			<u>1</u>
TOTAL COST - PART I			<u>442</u>

TABLE 3.1.2.3-III

INSTRUMENTATION - SINGLE STAGE

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	600	7,086			8	89			608	7,175
LAB TECHNICIANS	120	1,166			2	15			122	1,181
TOOLING					28	271			28	271
PRODUCTION										
MANUFACTURING TEST							1	13	1	13
MANUFACTURING TECH.					1	8			1	8
Q & RA	24	233			7	68		4	31	305
DIRECT DIST					7	68	1	4	8	72
TRAINING						4				4
TOTAL DIRECT LABOR	744	8,485			52	523	2	21	798	9,029
MATERIAL										
LAB. TECHNICIANS		252				3				255
TOOLING						35				35
PRODUCTION										
MFG. TECHNICIANS						1				1
Q&RA		7				2				9
SUBTOTAL		259				41				300
MAT. & ADM. BURDEN		88				14				102
TOTAL MATERIAL		347				55				402
TOTAL PART II COST		8,832				578		21		9,431

MLLV			
NON-RECURRING COSTS			
PART II		<u>INSTRUMENTATION SYSTEM - S/S</u>	
ASSEMBLY OR SYSTEM			
DESIGN ENGINEERING			
TABLE 3.1.2.3-IV		(IN THOUSANDS)	
<u>ELEMENT OF COST</u>		<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		600	7,086
1. Laboratory Technicians		<u>120</u>	<u>1,166</u>
Subtotal		720	8,252
2. Q&RA		24	233
TOTAL ENGINEERING LABOR		<u>744</u>	<u>8,485</u>
MATERIAL			
3. Laboratory Technicians			252
4. Q&RA		<u> </u>	<u>7</u>
Subtotal			259
5. Material and Adm. Burden			88
TOTAL MATERIAL			<u>347</u>
TOTAL ENGINEERING COST			<u>8,832</u>

MLLV
NON-RECURRING COSTS
INSTRUMENTATION SYSTEM - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.2.3-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		7,552	89,189
1. Lab. Tech.		<u>1,510</u>	<u>14,681</u>
TOTAL ENGR.		<u>9,062</u>	<u>103,870</u>
Fabrication and Erection			
Fab. & Assembly	20,000		194,400
Misc. Charges	1,560		15,163
Maintain & Add In Scope Changes	<u>220</u>		<u>2,138</u>
SUBTOTAL (A)	21,780		211,701
2. Tool and Production Planning	<u>6,098</u>		<u>59,276</u>
SUBTOTAL (B)	27,878		270,977
3. Direct Distributable	<u>6,970</u>		<u>67,745</u>
SUBTOTAL (C)	34,848		338,722
4. Training	<u>383</u>		<u>3,726</u>
SUBTOTAL (D)	35,231		342,448
5. Q&RA	7,046		68,489
6. Manufacturing Tech.	<u>669</u>		<u>7,904</u>
TOTAL PRODUCTION LABOR	<u>42,946</u>		<u>418,841</u>
MATERIAL			
7. Tooling			35,000
8. Lab. Tech.			3,171
9. Q&RA			2,113
10. Manufacturing Tech.			<u>1,171</u>
MATERIAL SUBTOTAL (E)			41,455
11. Material & Adm. Burden			14,095
TOTAL MATERIAL			<u>55,550</u>
TOTAL TOOLING COST			<u>578,261</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
INSTRUMENTATION SYSTEM - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 3.1.2.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,000	9,720
Component Test Planning	<u>320</u>	<u>3,110</u>
(1) Subtotal (A)	1,320	12,830
(2) Direct Distributable	<u>422</u>	<u>4,106</u>
Subtotal (B)	1,742	16,936
(3) Training	<u>19</u>	<u>186</u>
Subtotal (C)	1,761	17,122
(4) Mfg. Tech.	<u>33</u>	<u>394</u>
Subtotal (D)	1,794	17,516
(5) Q&RA	<u>352</u>	<u>3,424</u>
Total Mfg. Test Labor	<u>2,146</u>	<u>20,940</u>
Material		
(6) Q&RA		106
(7) Mfg. Tech.		<u>58</u>
Subtotal (E)		164
(8) Material & Adm. Burden		<u>56</u>
Total Material		<u>220</u>
Total Mfg. Test Cost		<u>21,160</u>

3.1.2.4 Flight Control System

TABLE 3.1.2.4-I
MLLV COST SUMMARY

FLIGHT CONTROL - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	40								3	40
PROGRAM PLAN. & REPT.	9	100								9	100
INDUSTRIAL RELATIONS	2	18								2	18
ENGINEERING			142	1,681						142	1,681
LAB TECHNICIANS			28	276						28	276
TOOLING			82	801						82	801
PRODUCTION											
MANUFACTURING TEST			4	38						4	38
MANUFACTURING TECH.			2	25						2	25
Q & R A			27	261						27	261
FACILITIES											
DIRECT DIST			22	212						22	212
TRAINING			1	12						1	12
TOTAL DIRECT LABOR	14	158	308	3,306						322	3,464
MATERIAL				176							176
LOGISTIC HARDWARE											
BURDEN				60							60
TOTAL MATERIAL				236							236
TOTAL OTHER											
TOTAL COST		158		3,542							3,700

MLLV

PART I

FLIGHT CONTROL - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.2.4-II

(In Thousands)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	142		
Logistics			
Laboratory Technician	28		
Production			
Tooling	82		
Manufacturing Test	4		
Q&RA	27		
Facilities			
Manufacturing Technician	2		
Total Direct Labor	<u>285</u>		
Program Executive		3	40
Program Planning & Reporting		9	100
Industrial Relations		2	18
Total Labor - Part I		<u>14</u>	<u>158</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>158</u>

TABLE 3.1.2.4-III
MLLV PART II COST SUMMARY

FLIGHT CONTROL - SINGLE STAGE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	120	1,417			22	264			142	1,681
LAB TECHNICIANS	24	233			4	43			28	276
TOOLING					82	801			82	801
PRODUCTION										
MANUFACTURING TEST							4	38	4	38
MANUFACTURING TECH.					2	24		1	2	25
Q&RA	5	49			21	202	1	10	27	261
DIRECT DIST					21	200	1	12	22	212
TRAINING					1	11		1	1	12
TOTAL DIRECT LABOR	149	1,699			154	1,545	6	62	309	3,306
MATERIAL										
LAB. TECHNICIANS		50				9				59
TOOLING						105				105
PRODUCTION										
MFG. TECHNICIANS						3				3
Q&RA		2				6		1		9
SUBTOTAL		52				123		1		176
MAT. & ADM. BURDEN		18				42				60
TOTAL MATERIAL		70				165		1		236
TOTAL PART II COST		1,769				1,710		63		3,542

MLLV
NON-RECURRING COSTS
PART II FLIGHT CONTROL SYSTEM - S/S

ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.1.2.4-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		120	1,417
1. Laboratory Technicians		<u>24</u>	<u>233</u>
Subtotal		144	1,650
2. Q&RA		5	59
TOTAL ENGINEERING LABOR		<u>149</u>	<u>1,699</u>
MATERIAL			
3. Laboratory Technicians			50
4. Q&RA		<u> </u>	<u>2</u>
Subtotal			52
5. Material and Adm. Burden			<u>18</u>
TOTAL MATERIAL			<u>70</u>
TOTAL ENGINEERING COST			<u>1,769</u>

MLLV
NON-RECURRING COSTS

FLIGHT CONTROL SYSTEM - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.2.4-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		22,316	263,552
1. Lab. Tech.		<u>4,463</u>	<u>43,382</u>
TOTAL ENGR.		<u>26,779</u>	<u>306,934</u>
Fabrication and Erection			
Fab. & Assembly	59,099		574,442
Misc. Charges	4,610		44,806
Maintain & Add In Scope Changes	<u>650</u>		<u>6,318</u>
SUBTOTAL (A)	64,359		625,566
2. Tool and Production Planning	<u>18,020</u>		<u>175,158</u>
SUBTOTAL (B)	82,379		800,724
3. Direct Distributable	<u>20,595</u>		<u>200,180</u>
SUBTOTAL (C)	102,974		1,000,904
4. Training	<u>1,133</u>		<u>11,010</u>
SUBTOTAL (D)	104,107		1,011,914
5. Q&RA	20,821		202,383
6. Manufacturing Tech.	<u>1,978</u>		<u>23,360</u>
TOTAL PRODUCTION LABOR	<u>126,906</u>		<u>1,237,657</u>
MATERIAL			
7. Tooling			104,423
8. Lab. Tech.			9,372
9. Q&RA			6,246
10. Manufacturing Tech.			<u>3,462</u>
MATERIAL SUBTOTAL (E)			123,503
11. Material & Adm. Burden			41,991
TOTAL MATERIAL			<u>165,494</u>
TOTAL TOOLING COST			<u>1,710,085</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

FLIGHT CONTROL SYSTEM - TOOLING - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.2.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	2,955	28,723
Component Test Planning	<u>946</u>	<u>9,191</u>
(1) Subtotal (A)	3,901	37,914
(2) Direct Distributable	<u>1,248</u>	<u>12,132</u>
Subtotal (B)	5,149	50,046
(3) Training	<u>57</u>	<u>550</u>
Subtotal (C)	5,206	50,596
(4) Mfg. Tech.	<u>99</u>	<u>1,168</u>
Subtotal (D)	5,305	51,764
(5) Q&RA	<u>1,041</u>	<u>10,119</u>
Total Mfg. Test Labor	<u><u>6,346</u></u>	<u><u>61,883</u></u>
Material		
(6) Q&RA		312
(7) Mfg. Tech.		<u>173</u>
Subtotal (E)		485
(8) Material & Adm. Burden		<u>165</u>
Total Material		<u><u>650</u></u>
Total Mfg. Test Cost		<u><u>62,533</u></u>

3.1.2.5 System Assembly

TABLE 3.1.2.5-I
MLLV COST SUMMARY

SYSTEMS ASSEMBLY - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	9	105								9	105
PROGRAM PLAN. & REPT.	22	263								22	263
INDUSTRIAL RELATIONS	5	47								5	47
ENGINEERING			600	7,086						600	7,086
LAB TECHNICIANS			120	1,166						120	1,166
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			24	233						24	233
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	36	415	744	8,485						780	8,900
MATERIAL		1		259							260
LOGISTIC HARDWARE											
BURDEN				88							88
TOTAL MATERIAL		1		347							348
TOTAL OTHER											
TOTAL COST		416		8,832							9,248

MLLV

PART I

Systems Assembly - S/S
ASSEMBLY OR SYSTEM

TABLE 3.1.2.5-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	600		
Logistics			
Laboratory Technician	120		
Production			
Tooling			
Manufacturing Test			
Q&RA	24		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>744</u>		
Program Executive		9	105
Program Planning & Reporting		22	263
Industrial Relations		<u>5</u>	<u>47</u>
Total Labor - Part I		<u>36</u>	<u>415</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			1
Material Subtotal			
Material & Administrative Burden			
Total Material			<u>1</u>
TOTAL COST - PART I			<u>416</u>

TABLE 3.1.2.5-III

SYSTEMS ASSEMBLY - SINGLE STAGE

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	600	7,086							600	7,086
LAB TECHNICIANS	120	1,166							120	1,166
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & RA	24	233							24	233
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	744	8,485							744	8,485
MATERIAL										
LAB. TECHNICIANS		252								252
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q&RA		7								7
SUBTOTAL		259								259
MAT. & ADM. BURDEN		88								88
TOTAL MATERIAL		347								347
TOTAL PART II COST		8,832								8,832

MLLV			
NON-RECURRING COSTS			
PART II	<u>SYSTEMS ASSEMBLY - S/S</u>		
	ASSEMBLY OR SYSTEM		
	DESIGN ENGINEERING		
<u>ELEMENT OF COST</u>	TABLE 3.1.2.5-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		600	7,086
1. Laboratory Technicians		<u>120</u>	<u>1,166</u>
Subtotal		720	8,252
2. Q&RA		24	233
TOTAL ENGINEERING LABOR		<u>744</u>	<u>8,485</u>
MATERIAL			
3. Laboratory Technicians			252
4. Q&RA			<u>7</u>
Subtotal			259
5. Material and Adm. Burden			<u>88</u>
TOTAL MATERIAL			<u>347</u>
TOTAL ENGINEERING COST			<u>8,832</u>

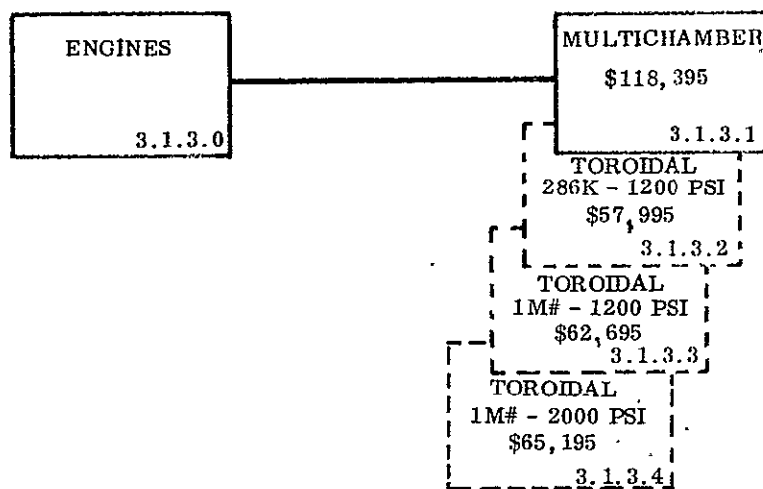
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3.1.3 Liquid Engine Costs

This section shows the Get Ready Costs for the following types of propulsion systems:

- 3.1.3.1 Multichamber/Plug (with 24 modules having fixed nozzles and a vacuum thrust per module of 388,000 pounds)
- 3.1.3.2 Toroidal/Aerospike (1200 psia with 28 modules, each producing 286,000 pound thrust)
- 3.1.3.3 Toroidal/Aerospike (1200 psia with 8 modules, each producing one million pound thrust)
- 3.1.3.4 Toroidal/Aerospike (2000 psia with 8 modules, each producing one million pound thrust/module)

Figure 3.1.3.0-1 shows the MLLV get ready, "A" costs for the multichamber/plug engine system. Alternative toroidal/aerospike engine systems costs are also shown.



NOTES:-----ALTERNATE SYSTEMS.
 DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.1.3.0-1 AMLIV MAIN STAGE ENGINE OPTIONS COSTS GET READY, "A" COSTS

3.1.3.1 Multichamber/Plug Engine

Parametric cost data was received from Pratt and Whitney for the multichamber/plug propulsion system. This data covered a range of propulsion system sizes; i.e., from above the requirements for a full size AMLLV engine to below that of a half size (MLLV) engine (Figure 3.1.3.1-1). The data received included the total cost for engine development, PFRT and Qualifications Testing as a function of Module Vacuum Thrust.

As stated in Section 1.0, of this book, the program development costs (for the purpose of this study) were sub-divided into two categories: (1) Get Ready or "A" costs, and (2) Development Testing or "B" costs. Since the parametric data (Figure 3.1.3.1-1) included costs associated with both categories, it was necessary to establish the appropriate costs associated for each of the categories. The allocating pertaining to Get Ready costs will be discussed herein (The Development Test costs will be discussed in Book B).

The only cost data received, that reflected program costs for engine development (by "A" and "B" cost categories), was that submitted by Rocketdyne on the 1200 psia toroidal/aerospike engine system. Figure 3.1.3.1-2 displays, in terms of percentages, the elements of cost developed from this data.

The percentages developed were then applied to the multichamber/plug propulsion system total development costs to divide it into get ready and development test costs. The example below illustrates how these costs were divided.

Example: Pratt and Whitney total cost \$345 million X 22.7% (from Figure 3.1.3.1-2) = \$78,300 M Get Ready Cost (the remainder being used in the Development Test or "B" costs).

Table 3.1.3.1-I displays the results of this exercise. These costs were also supplemented by other costs for facilities and capital equipment.

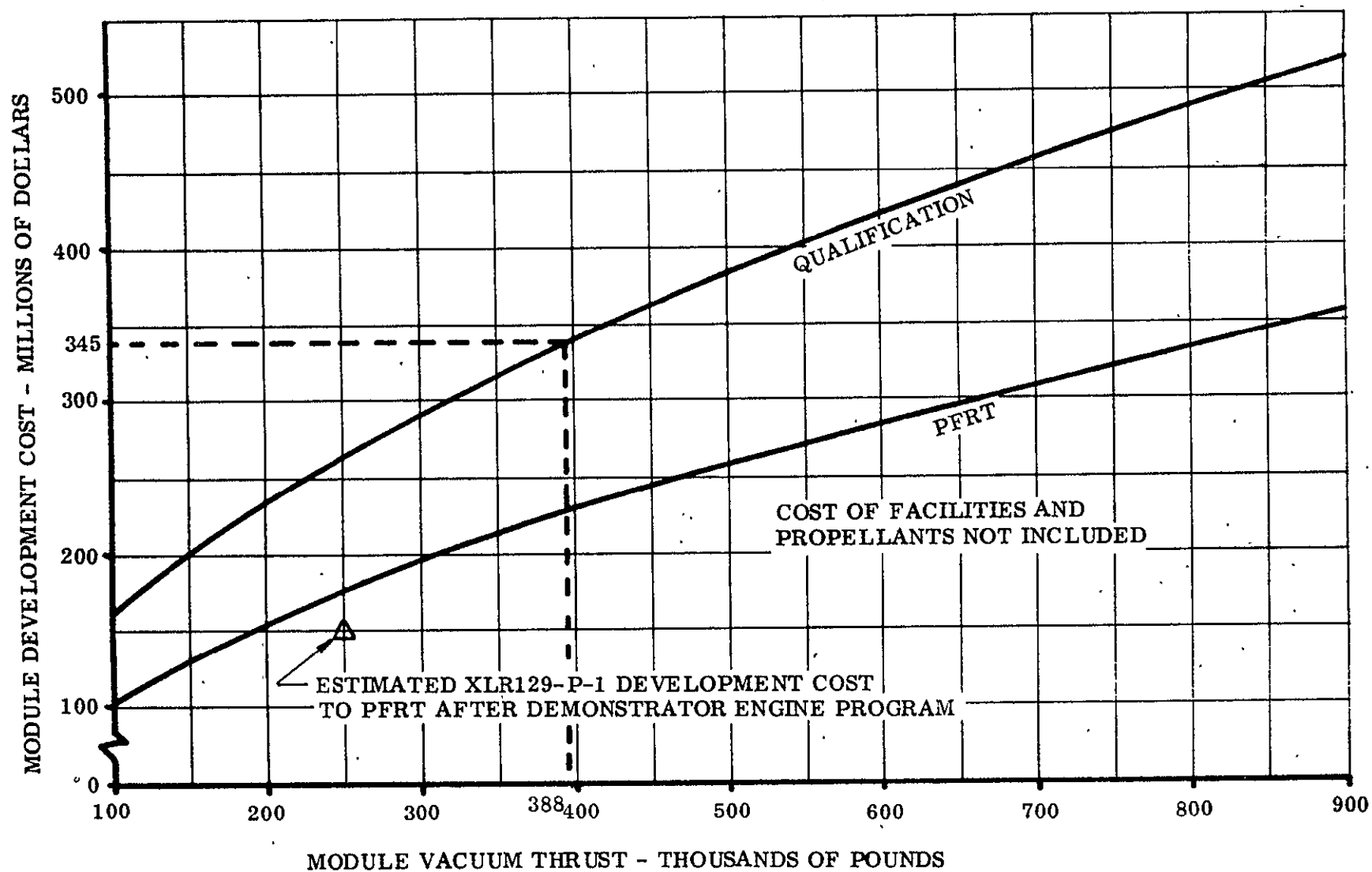


FIGURE 3.1.3.1-1 MLLV MAIN STAGE PROPULSION SYSTEM - ESTIMATED MODULE DEVELOPMENT COSTS. OXYGEN/HYDROGEN MULTICHAMBER/PLUG PROPULSION SYSTEM (PRATT & WHITNEY DATA)

TABLE 3.1.3.1-I
MLLV COST SUMMARY

LIQUID ENGINES - SINGLE STAGE
(MULTI-CHAMBER)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				26,400							26,400
LAB TECHNICIANS											
TOOLING				32,300							32,300
PRODUCTION				8,000							8,000
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				66,700							66,700
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						40,095			*11,600		51,695
TOTAL COST				66,700		40,095			11,600		118,395

* GSE

MLLV
SINGLE STAGE ENGINE
~~MULTI-CHAMBER~~
PLUG ENGINE

TABLE 3.1.3.1-II

"A"- COSTS

Engineering	\$26.4M	
Test		
Equipment	1.0M	
Tooling (Basic)	9.2M	
Fabrication	<u> </u>	
Subtotal		\$36.6M

Production

Tooling (Basic)	\$23.1M	
Equipment	7.0M	
GSE	<u>11.6M</u>	
Subtotal		\$41.7M

\$78.3M

"A" + "B" = \$345.0M

MLLV
LIQUID ENGINE FACILITIES AND EQUIPMENT

TABLE 3.1.3.1-III

	<u>Facilities</u>	<u>Equipment</u>
Non-Recurring		
Single Stage	\$20,888,000	\$19,207,000

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3.1.3.2 Toroidal/Aerospike Engine Cost (286,000 Pound Thrust - 1200 psia)

This paragraph presents the Get Ready cost for a toroidal/aerospike engine system consisting of twenty-eight 1200 psia modules, each of which will produce 286,000 pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne.

Figure 3.1.3.1-2 displays, in terms of percentages, a breakdown of the A and B categories.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 3.1.3.1-I above. The toroidal/aerospike engine costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

	GET READY OR "A" PERCENTAGES	DEVELOPMENT TEST OR "B" PERCENTAGES			
		COMPONENT	ENGINE	PFRT	QUAL.
Design and Development					
Engineering	72.2%	46.8%	34.7%	35.1%	35.1%
Test	-0-	22.6	12.7	8.8	8.8
Equipment	2.5	4.0	5.8	-0-	-0-
Tooling (Basic)	25.3	4.0	3.9	-0-	-0-
Fabrication	-0-	22.6	42.9	56.1	56.1
	<u>100%</u>	<u>100%</u>	<u>100%</u>	<u>100%</u>	<u>100%</u>
Subtotal	46.8%	24.9%	52.1%	11.5%	11.5%
Production (Non-Recurring)					
Tooling (Basic)	55.5%				
Equipment	16.7%				
GSE	27.8%				
	<u>100%</u>				
Subtotal	53.2%				
	22.7%		77.3%		
Total		100%			

NOTE: Percentages based on 1200 psia 286K pound thrust module, as submitted by Rocketdyne in memo No. 68RC-16347 dated 20 December 1968.

These percentages were:

- (1) Used as is for the 1200 psia, 287K pounds thrust engine
- (2) Used to allocate the amounts applicable to "A" and "B" cost categories on the Multichamber/Plug engine.

FIGURE 3.1.3.1-2 DEVELOPMENT COST FOR 1200 PSIA TOROIDAL/AEROSPIKE PROPULSION SYSTEM
DIVIDED INTO PERCENTAGES OF GET READY AND DEVELOPMENT TEST COST -
BASED ON 1200 PSIA - 286,000 POUND THRUST MODULE

TABLE 3.1.3.2-I

MLLV COST SUMMARY SINGLE STAGE ENGINES (TORIDAL)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				5,700							5,700
LAB TECHNICIANS											
TOOLING				7,000							7,000
PRODUCTION				1,700							1,700
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				14,400							14,400
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						40,095			*3,500		43,595
TOTAL COST				14,400		40,095			3,500		57,995

* GSE, Fee, Facilities

MLLV
TORIDAL ENGINE PROGRAM
286 K THRUST PER MODULE
1200 PSI

TABLE 3.1.3.2-II

(In Millions)

A. Development Prime

Design

Engineering	\$ 5.7
Test	
Equipment	.2
Tooling (Basic)	2.0
Fabrication	<u> </u>

Subtotal (Inc. Fee)	\$ 7.9
---------------------	--------

*Other Non-Recurring

Tooling (Basic)	\$ 5.0
Equipment	1.5
GSE	2.5
Fee	<u>1.0</u>

Subtotal	\$10.0
----------	--------

TOTAL	\$17.9
-------	--------

*NOTE: Input from Rocketdyne Indicated this Cost as Production, Non-Recurring.

Facilities - see Multichamber

3.1.3.3 Toroidal/Aerospike Engine Cost (One Million Pound Thrust - 1200 psia)

This paragraph presents the Get Ready Cost for a toroidal/aerospike engine system consisting of eight 1200 psia modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne. However, the costs for the "A" and "B" categories were combined.

Figure 3.1.3.3-1 displays in terms of percentage, the breakdown of "A" and "B" costs. These percentages and the results are displayed in Table 3.1.3.3-I.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle as shown in Table 3.1.3.1-I above. The toroidal/aerospike cost must be substituted in lieu the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system

	GET READY OR "A" PERCENTAGES	DEVELOPMENT TEST OR "B" PERCENTAGES			
		COMPONENT	ENGINE	PFRT	QUAL.
Design and Development					
Engineering	68.2%	28.8%	26.7%	25.5%	25.5%
Test	-0-	13.9	6.7	6.4	6.4
Equipment	4.5	12.6	20.3	-0-	-0-
Tooling (Basic)	27.3	5.2	1.8	-0-	-0-
Fabrication	-0-	39.5	44.5	68.1	68.1
	<u>100%</u>	<u>100%</u>	<u>100%</u>	<u>100%</u>	<u>100%</u>
Subtotal	51.1%	34.5%	48.5%	8.5%	8.5%
Production (Non-Recurring)					
Tooling (Basic)	38.1%				
Equipment	23.8				
GSE	38.1				
	<u>100%</u>				
Subtotal	48.9%				
	16.3%		83.7%		
Total		100%			

Percentages based on 1200 psia one million pound thrust module, as submitted by Rocketdyne, in memo No. 68RC-16347 dated 20 December 1968.

This percentage was:

- (1) Used as is for the 1200 psia, one million pound module and for the 2000 psia, one million pound module.

TABLE 3.1.3.3-1 . DEVELOPMENT COSTS FOR THE 1200 AND 2000 PSIA TOROIDAL/AEROSPIKE PROPULSION SYSTEM DIVIDED INTO PERCENTAGES OF GET READY AND DEVELOPMENT TEST COSTS - BASED ON 1200 PSIA - 1 MILLION POUND THRUST MODULE

TABLE 3.1.3.3-I

MLLV COST SUMMARY

SINGLE STAGE ENGINES

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				7,500							7,500
LAB TECHNICIANS											
TOOLING				7,000							7,000
PRODUCTION				3,000							3,000
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				17,500							17,500
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						40,095			*5,100		45,195
TOTAL COST				17,500		40,095			5,100		62,695

* GSE, Fee, Facilities

MLLV
TOROIDAL ENGINE PROGRAM
1m THRUST PER MODULE
1200 PSI

TABLE 3.1.3.3-II

(In Millions)

A. Development Prime

Design

Engineering	\$ 7.5
Test	
Equipment	.5
Tooling (Basic)	3.0
Fabrication	<u> </u>
Subtotal (Inc. Fee)	\$11.0

Production

Tooling (Basic)	\$ 4.0
Equipment	2.5
GSE	4.0
Fee	<u>1.1</u>
Subtotal	\$11.6

TOTAL

\$22.6

Facilities - See Multichamber

3.1.3.4 Toroidal/Aerospike Engine Cost (One Million Pound Thrust - 2000 psia)

This paragraph presents the Get Ready Cost for a toroidal/aerospike engine system consisting of eight 2000 psia modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne. However, the costs for the "A" and "B" categories were combined.

In order to determine that amount which applied to "A" costs only, the same percentage apportionment between "A" and "B" costs used for the 1200 psia one million modules was applied to the 2000 psia one million propulsion system. Figure 3.1.3.3-1 displays, in terms of percentage, this breakdown of the categories. These percentages were then applied to the 2000 psia one million module data and the results are displayed in Table 3.1.3.4-I.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle as shown in Table 3.1.3.1-I above. The toroidal/aerospike cost must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

TABLE 3.1.3.4-I

MLLV COST SUMMARY SINGLE STAGE ENGINES (TOROIDAL)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				9,200							9,200
LAB TECHNICIANS											
TOOLING				7,700							7,700
PRODUCTION				3,100							3,100
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				20,000							20,000
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						40,095			*5,100		45,195
TOTAL COST				20,000		40,095			5,100		65,195

* GSE, Fee, Facilities

MLLV
TOROIDAL ENGINE PROGRAM
1M THRUST PER MODULE
2000 PSI

TABLE 3.1.3.4-II

"A" GET READY

(Dollars In Millions)

<u>Engineering</u>	9.2	
Test		
Equipment	.6	
Tooling (Basic)	3.7	
Fabrication	<u> </u>	
Subtotal	<u>13.5</u>	
(Incl. Fee)		
 <u>Production</u>		
Tooling (Basic)	4.0	
Equipment	2.5	
GSE	<u>4.0</u>	
	10.5	
(Incl. Fee)	11.6	
Total		<u><u>25.1</u></u>

(A&B = \$161.6M)

Facilities - See Multichamber

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3.1.4 Ground Support Equipment (GSE)

The Get Ready Costs of the Ground Support Equipment (GSE) required for the single stage vehicle include such items as:

Test and Checkout Equipment:

- Electrical test station
- Mechanical test station
- Data system test station
- Interconnection equipment
- Checkout auxiliary equipment
- Test, checkout, calibration and maintenance equipment
- Sub-systems test equipment
- Sub-assemblies and parts test
- Data processing station

Handling and Transportation Equipment:

- General equipment
- Stage handling equipment
- Component handling equipment
- Stage transportation equipment

The Get Ready Costs associated with this equipment is displayed in Table 3.1.4.0-I.

TABLE 3.1.4.0-I

GSE - SINGLE STAGE

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	46	540								46	540
PROGRAM PLAN. & REPT.	114	1,351								114	1,351
INDUSTRIAL RELATIONS	25	240								25	240
ENGINEERING											
LAB TECHNICIANS											
TOOLING			2,850	27,700						2,850	27,700
PRODUCTION											
MANUFACTURING TEST			135	1,312						135	1,312
MANUFACTURING TECH.			71	848						71	848
Q & R A			758	7,358						758	7,358
FACILITIES											
DIRECT DIST			755	7,344						755	7,344
TRAINING			41	400						41	400
TOTAL DIRECT LABOR	185	2,131	4,610	44,962						4,795	47,093
MATERIAL		4		8,550							8,554
LOGISTIC HARDWARE											
BURDEN		2		2,907							2,909
TOTAL MATERIAL		6		11,457							11,463
TOTAL OTHER											
TOTAL COST		2,137		56,419							58,556

MLLV

PART I

GSE - S/S

ASSEMBLY OR SYSTEM

TABLE 3.1.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production			
Tooling	2,850		
Manufacturing Test	135		
Q&RA	758		
Facilities			
Manufacturing Technician	71		
Total Direct Labor	3,814		
Program Executive		46	540
Program Planning & Reporting		114	1,351
Industrial Relations		25	240
Total Labor - Part I		185	2,131
<u>Material</u>			
Program Planning & Reporting			2
Industrial Relations			2
Material Subtotal			4
Material & Administrative Burden			2
Total Material			6
TOTAL COST - PART I			2,137

TABLE 3.1.4.0-III

GSE - S/S

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					2,850	27,700			2,850	27,700
PRODUCTION										
MANUFACTURING TEST							135	1,312	135	1,312
MANUFACTURING TECH.					68	808	3	40	71	848
Q & R A					721	7,001	37	357	758	7,358
DIRECT DIST					712	6,925	43	420	755	7,345
TRAINING					39	381	2	19	41	400
TOTAL DIRECT LABOR					4,390	42,815	220	2,147	4,610	44,962
MATERIAL										
LAB. TECHNICIANS										
TOOLING						8,362				8,362
PRODUCTION										
MFG. TECHNICIANS						120		6		126
Q & R A						51		11		62
SUBTOTAL						8,533		17		8,550
MAT. & ADM. BURDEN						2,901		6		2,907
TOTAL MATERIAL						11,434		23		11,457
TOTAL PART II COST						54,249		2,170		56,419

MLLV
NON-RECURRING COSTS

GSE - S/S
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.1.4.0-IV

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	(IN THOUSANDS) <u>COLUMN III DOLLARS</u>
TOOL DESIGN			
1. Lab. Tech.			
TOTAL ENGR.			
Fabrication and Erection			
Fab. & Assembly	2,044,425		19,872
Misc. Charges	159,465		1,550
Maintain & Add In Scope Changes	22,489		218
SUBTOTAL (A)	2,226,379		21,640
2. Tool and Production Planning	623,386		6,060
SUBTOTAL (B)	2,849,765		27,700
3. Direct Distributable	712,441		6,925
SUBTOTAL (C)	3,562,206		34,625
4. Training	39,184		381
SUBTOTAL (D)	3,601,390		35,006
5. Q&RA	720,278		7,001
6. Manufacturing Tech.	68,426		808
TOTAL PRODUCTION LABOR	4,390,094		42,815
MATERIAL			
7. Tooling			8,362
8. Lab. Tech.			51
9. Q&RA			120
10. Manufacturing Tech.			
MATERIAL SUBTOTAL (E)			8,533
11. Material & Adm. Burden			2,901
TOTAL MATERIAL			11,434
TOTAL TOOLING COST			54,249

* Included in Fabrication and Assembly

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

GSE - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.1.4.0-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	102,221	993,588
Component Test Planning	<u>32,711</u>	<u>317,951</u>
(1) Subtotal (A)	134,932	1,311,539
(2) Direct Distributable	<u>43,178</u>	<u>419,690</u>
Subtotal (B)	178,110	1,731,229
(3) Training	<u>1,959</u>	<u>19,042</u>
Subtotal (C)	180,069	1,750,271
(4) Mfg. Tech.	<u>3,421</u>	<u>40,402</u>
Subtotal (D)	183,490	1,790,673
(5) Q&RA	<u>36,698</u>	<u>356,705</u>
Total Mfg. Test Labor	<u>220,188</u>	<u>2,147,378</u>
Material		
(6) Q&RA		11,009
(7) Mfg. Tech.		<u>5,987</u>
Subtotal (E)		16,996
(8) Material & Adm. Burden		<u>5,779</u>
Total Material		<u>22,775</u>
Total Mfg. Test Cost		<u>2,170,153</u>

MLLV
PART II
NON-RECURRING COST
GSE - S/S

TABLE 3.1.4.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Material</u>
Test and Checkout Equipment:		
General Equipment	70,225	287,220
Electrical Test Station	2,240	9,160
Mechanical Test Station	4,663	19,072
Data Systems Test Station	10,480	42,863
Interconnect Equipment	72,360	295,952
C/O Auxilliary Equipment	111,650	456,649
Test, C/O, Calibration and Maintenance Equipment	2,385	9,755
Subsystems Test Equipment	360,485	1,474,384
Subassemblies and Parts Test	407,065	1,664,896
Data Processing Station	568	2,323
Engine Test & C/O Equipment	51,805	211,882
Handling and Transportation Equipment:		
General Equipment	33,438	136,761
Stage Handling Equipment	788,003	3,222,932
Component Handling Equipment	106,433	435,311
Stage Transportation Equipment	20,195	82,598
Engine Handling Equipment	2,430	9,939
Total MGSE	2,044,425	8,361,697

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3.1.5 Manufacturing Facility

The Get Ready Costs include costs for construction of the manufacturing building, the vertical assembly building, post manufacturing and stage test building, the office building, and the capital equipment. For a detailed description of the manufacturing facility refer to the Volume III of this report.

Transportation costs are also included for such items as the barges (for stage transportation), the tow vehicle, the land transporter, and the cost for the barge trip from the manufacturing facility to the launch site.

The total cost of these activities for the Single Stage Vehicle is displayed in Table 3.1.5.0-I.

MANUFACTURING FACILITIES - SINGLE STAGE

TABLE 3.1.5.0-1
MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						155,138					155,138
TOTAL COST						155,138					155,138

MLIV
NON-RECURRING COST SUMMARY

SINGLE STAGE
FACILITIES & TRANSPORTATION
(DOLLARS IN THOUSANDS)

TABLE 3.1.5.0-II

(IN THOUSANDS)

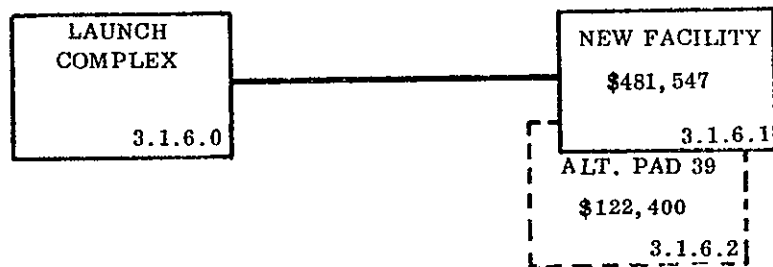
<u>Element of Cost</u>	<u>Facilities</u>	<u>Equipment</u>	<u>Transportation</u>
Manufacturing Bldg.	\$ 73,875	\$40,316	
Vertical Assy. Bldg.	11,550	4,144	
Post Mfg. & Stage Test Bldg.	3,600	300	
Office	<u>13,406</u>	<u>1,553</u>	
Subtotal	<u>\$102,431</u>	<u>\$46,313</u>	
<u>Transportation</u>			
Barge			\$ 4,157
Tow Vehicle			82
Land Transporter			<u>2,155</u>
Subtotal			<u>\$ 6,394</u>
Totals			
Transportation			<u>\$ 6,394</u>
Equipment			<u>46,313</u>
Facilities			<u>102,431</u>
MANUFACTURING FACILITIES COST			<u>\$155,138</u>

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3.1.6 Launch Complex Facility

The Launch Complex Facility for the Single Stage Vehicle consists of land, buildings, utility systems, machinery, laboratory equipment, electronic equipment, furniture, office equipment, vehicles and other equipment used in launching operations. For a further discussion of this facility refer to Volume III of this report.

Launch Facility costs are provided for (1) a new facility, refer to Paragraph 3.1.6.1, and (2) an alternate launch facility, refer to Paragraph 3.1.6.2. Figure 3.1.6.0-1 shows the cost of a new facility and offers as an alternative launch facility the use of Launch Complex 39.



NOTES:----- ALTERNATE SYSTEMS.
 DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.1.6.0-1 MLLV SINGLE STAGE TO ORBIT VEHICLE LAUNCH COMPLEX
 FACILITY GET READY, "A" COSTS

TABLE 3.1.6.1-I
MLLV COST SUMMARY

SUMMARY LAUNCH COMPLEX FACILITIES - S/S

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						481,547					481,547
TOTAL COST						481,547					481,547

MLLV
LAUNCH COMPLEX FACILITIES
NON-RECURRING
(DOLLARS IN THOUSANDS)

TABLE 3.1.6.1-II

BRICK AND MORTAR

1.	Site Development Canal, Hyd. Fill, etc.	\$ 30,000	
2.	Reinforce Concrete Launch Pad (Flame Deflect)	100,000	
3.	Propellant Storage and Transfer and Disposal Systems	83,250	
4.	Launch and Test Control Center	20,000	
5.	Off-Site Support Complex	31,613	
6.	Stage Storage Acceptance Test and Checkout	<u>1,000</u>	
			\$265,863

GROUND SUPPORT EQUIPMENT

1.	Gantry Equipment	\$ 10,000	
2.	Service Structure	40,000	
3.	Umbilical Tower	10,000	
4.	SRM Aft Support Structure	2,500	
5.	Core Support and Hold Down Boom	<u>8,000</u>	
			\$ 70,500

EQUIPMENT (GENERAL)

1.	Test	125,000	
2.	Off Site Support	<u>20,184</u>	
			<u>\$145,184</u>

TOTAL			\$481,547
-------	--	--	-----------

3.1.6.2 Launch Complex Facility - Launch Complex 39

The Get Ready Cost for the Single Stage Vehicle from the existing Launch Complex 39 would require the following new items:

- Mobile Launcher
- Mobile Service Structure
- Firing Room

The Launch Pad, Vertical Assembly Building, and Hydrogen Facility would require modification only. The total cost of this effort is displayed in Table 3.1.6.2-I.

TABLE 3.1.6.2-I
MLLV COST SUMMARY

SUMMARY - LAUNCH COMPLEX FACILITIES PAD 39 - SINGLE STAGE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						122,400					122,400
TOTAL COST						122,400					122,400

MLLV
NON-RECURRING

*LAUNCH COMPLEX FACILITIES AND EQUIPMENT
(DOLLARS IN THOUSANDS)

TABLE 3.1.6.2-II

<u>ITEM</u>	<u>DOLLARS</u>
LAUNCH PAD	1,000
MOBILE LAUNCHER	51,000
MOBILE SERVICE STRUCTURE	17,000
VEHICLE ASSEMBLY BLDG. MOD.	400
FIRING ROOM	52,000
HYDROGEN FACILITY	<u>1,000</u>
TOTAL	122,400

*Required for launching single-stage MLLV from Launch Complex Pad 39.

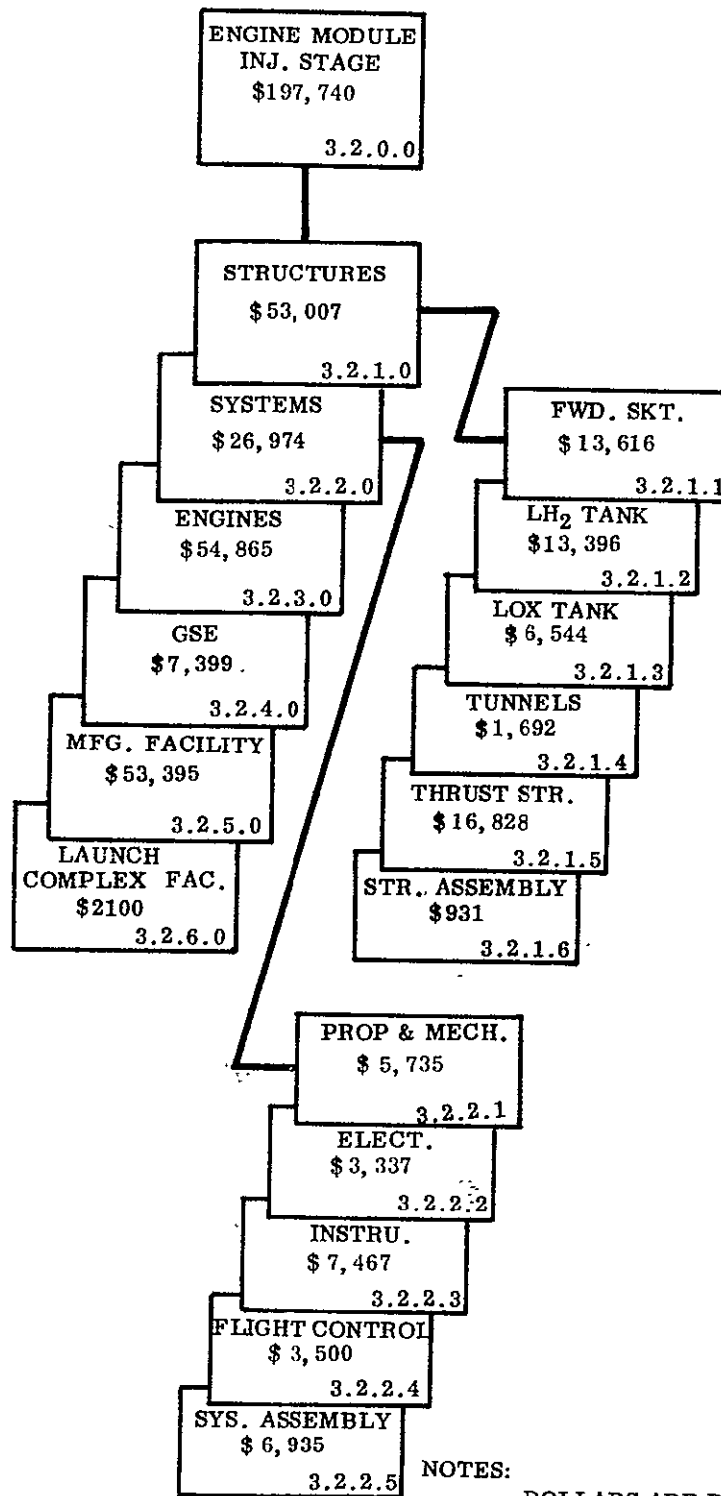
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3.2 ENGINE MODULE - INJECTION STAGE

The Get Ready Summary Costs for the injection stage - engine module are displayed in Figure 3.2.0.0-1. Table 3.2.0.0-I displays the total cost for the injection stage-engine module by Part and by Element of Cost.

These costs include the cost associated with designing the hardware structures, systems, the liquid engines, the Ground Support Equipment (GSE), the production facility and the launch complex facility.



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.2.0.0-1 MLLV INJECTION STAGE ENGINE MODULE GET READY, "A" COSTS

TABLE 3.2.0.0-I
MLLV COST SUMMARY

ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	78	926								78	926
PROGRAM PLAN.& REPT.	199	2,335								199	2,335
INDUSTRIAL RELATIONS	44	412								44	412
ENGINEERING			2,638	45,167						2,638	45,167
LAB TECHNICIANS			528	5,131						528	5,131
TOOLING			2,518	41,656						2,518	41,656
PRODUCTION				4,200							4,200
MANUFACTURING TEST			116	1,134						116	1,134
MANUFACTURING TECH.			65	747						65	747
Q & R A			749	7,291						749	7,291
FACILITIES											
DIRECT DIST			669	6,477						669	6,477
TRAINING			34	352						34	352
TOTAL DIRECT LABOR	321	3,673	7,317	112,155						7,638	115,828
MATERIAL		8		5,183							5,193
LOGISTIC HARDWARE											
BURDEN				1,759							1,759
TOTAL MATERIAL		8		6,944							6,952
TOTAL OTHER					55,495		*	19,465			74,960
TOTAL COST		3,681		119,099	55,495			19,465			197,740

* See Engines

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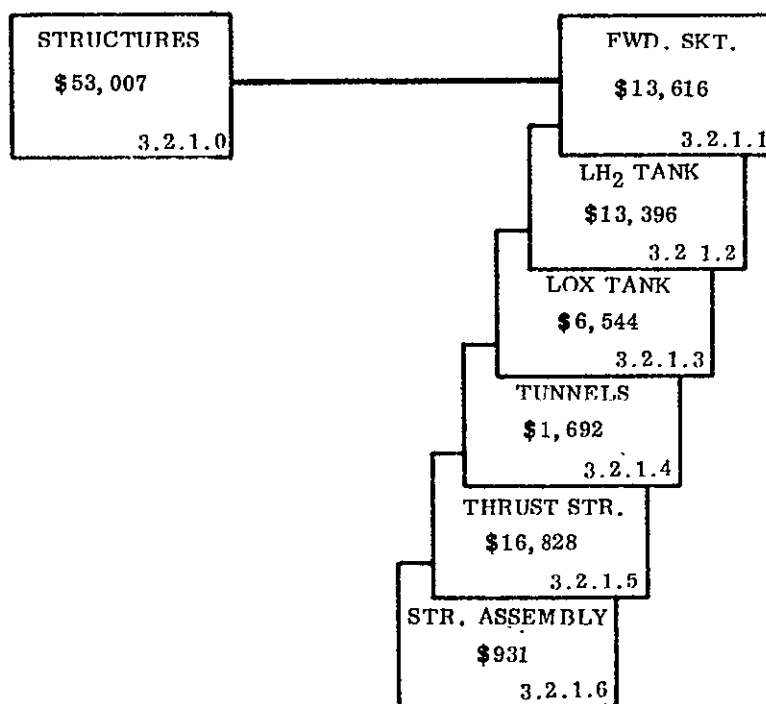
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3.2.1 Structures - Injection Stage - Engine Module

The Get Ready Cost for the structural components of the injection stage - engine module are displayed in Figure 3.2.1.0-1. The cost details of these structural components are contained in the appropriate subparagraphs, as indicated.

Table 3.2.1.0-I is a total Get Ready Cost of these structures.

These costs are comprised of basic (or non-recurring) engineering costs required to produce the basic tooling, fabrication and assembly of tooling, and basic article design including all engineering such as manufacturing liaison and coordination required to produce the first article. These costs are non-recurring in that they are experienced once during the production life of a model.



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

GURE 3.2.1.0-1 MLLV INJECTION STAGE - ENGINE MODULE STRUCTURES COSTS GET READY,
 "A" COSTS

TABLE 3.2.1.0-I

MLLV COST SUMMARY STRUCTURES - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	47	560								47	560
PROGRAM PLAN. & REPT.	119	1,410								119	1,410
INDUSTRIAL RELATIONS	26	249								26	249
ENGINEERING			1,092	12,915						1,092	12,915
LAB TECHNICIANS			219	2,126						219	2,126
TOOLING			1,986	19,293						1,986	19,293
PRODUCTION											
MANUFACTURING TEST			94	915						94	915
MANUFACTURING TECH.			51	591						51	591
Q & R A			548	5,341						548	5,341
FACILITIES											
DIRECT DIST			528	5,116						528	5,116
TRAINING			28	278						28	278
TOTAL DIRECT LABOR	192	2,219	4,546	46,575						4,738	48,794
MATERIAL		6		3,141							3,147
LOGISTIC HARDWARE											
BURDEN				1,066							1,066
TOTAL MATERIAL		6		4,207							4,213
TOTAL OTHER											
TOTAL COST		2,225		50,782							53,007

3.2.1.1 Forward Skirt

TABLE 3.2.1.1-I
MLLV COST SUMMARY

FORWARD SKIRT - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	12	143								12	143
PROGRAM PLAN.& REPT.	30	359								30	359
INDUSTRIAL RELATIONS	7	64								7	64
ENGINEERING			225	2,663						225	2,663
LAB TECHNICIANS			45	439						45	439
TOOLING			556	5,399						556	5,399
PRODUCTION											
MANUFACTURING TEST			26	256						26	256
MANUFACTURING TECH.			14	165						14	165
Q & R A			150	1,462						150	1,462
FACILITIES											
DIRECT DIST			148	1,432						148	1,432
TRAINING			8	78						8	78
TOTAL DIRECT LABOR	49	566	1,172	11,894						1,221	12,460
MATERIAL		2		861							863
LOGISTIC HARDWARE											
BURDEN				293							293
TOTAL MATERIAL		2		1,154							1,156
TOTAL OTHER											
TOTAL COST		568		13,048							13,616

MLLV

PART I

FORWARD SKIRT - ENGINE MODULE
ASSEMBLY OR SYSTEM

TABLE 3.2.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering 225			
Logistics			
Laboratory Technician 45			
Production			
Tooling 556			
Manufacturing Test 26			
Q&RA 150			
Facilities			
Manufacturing Technician 14			
Total Direct Labor	<u>1,016</u>		
Program Executive	12		143
Program Planning & Reporting	30		359
Industrial Relations	7		64
Total Labor - Part I	<u>49</u>		<u>\$566</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			
Total Material			<u>2</u>
TOTAL COST - PART I			<u>\$568</u>

TABLE 3.2.1.1-III

FORWARD SKIRT - ENGINE MODULE

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	75	886			150	1,777			225	2,663
LAB TECHNICIANS	15	146			30	293			45	439
TOOLING					556	5,399			556	5,399
PRODUCTION										
MANUFACTURING TEST							26	256	26	256
MANUFACTURING TECH.					13	158	1	7	14	165
Q&RA	3	29			140	1,365	7	68	150	1,462
DIRECT DIST					139	1,350	9	82	148	1,432
TRAINING					8	74		4	8	78
TOTAL DIRECT LABOR	93	1,061			1,036	10,416	43	417	1,172	11,894
MATERIAL										
LAB. TECHNICIANS		31				63				94
TOOLING						697				697
PRODUCTION										
MFG. TECHNICIANS						23		1		24
Q&RA		1				42		2		45
SUBTOTAL		32				826		3		861
MAT. & ADM. BURDEN		11				281		1		293
TOTAL MATERIAL		43				1,107		4		1,154
TOTAL PART II COST		\$1,104				\$11,523		\$421		\$13,048

MLIV
NON-RECURRING COSTS
PART II-A FORWARD SKIRT - ENGINE MODULE
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING
TABLE 3.2.1.1-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>75,000</u>	\$ <u>885,750</u>
1. Laboratory Technicians	<u>15,000</u>	<u>145,800</u>
Subtotal	<u>90,000</u>	\$ <u>1,031,550</u>
2. Q&RA	<u>3,000</u>	<u>29,160</u>
TOTAL ENGINEERING LABOR	<u>93,000</u>	\$ <u>1,060,710</u>
MATERIAL		
3. Laboratory Technicians		\$ <u>31,500</u>
4. Q&RA		<u>900</u>
Subtotal		\$ <u>32,400</u>
5. Material and Adm. Burden		<u>11,016</u>
TOTAL MATERIAL		\$ <u>43,416</u>
TOTAL ENGINEERING COST		\$ <u>1,104,126</u>

MLLV
NON-RECURRING COSTS

FORWARD SKIRT - ENGINE MODULE
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.1.1-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>150,483</u>	<u>\$1,777,204</u>
1. Lab. Tech.		<u>30,097</u>	<u>292,539</u>
TOTAL ENGR.		<u>180,580</u>	<u>2,069,743</u>
Fabrication and Erection			
Fab. & Assembly	<u>398,525</u>		<u>3,873,663</u>
Misc. Charges 7.8%	<u>31,085</u>		<u>302,145</u>
Maintain & Add			
In Scope Changes 1.1%	<u>4,384</u>		<u>43,610</u>
SUBTOTAL (A)	<u>433,994</u>		<u>4,218,418</u>
2. Tool and Production Planning	<u>121,518</u>		<u>1,181,157</u>
SUBTOTAL (B)	<u>555,512</u>		<u>5,399,575</u>
3. Direct Distributable	<u>138,878</u>		<u>1,349,893</u>
SUBTOTAL (C)	<u>694,390</u>		<u>6,749,468</u>
4. Training	<u>7,638</u>		<u>74,243</u>
SUBTOTAL (D)	<u>702,028</u>		<u>6,823,711</u>
5. Q&RA	<u>140,406</u>		<u>1,364,741</u>
6. Manufacturing Tech.	<u>13,339</u>		<u>157,528</u>
TOTAL PRODUCTION LABOR	<u>855,773</u>		<u>\$8,345,980</u>
MATERIAL			
7. Tooling			<u>\$ 697,419</u>
8. Lab. Tech.			<u>63,204</u>
9. Q&RA			<u>42,122</u>
10. Manufacturing Tech.			<u>23,343</u>
MATERIAL SUBTOTAL (E)			<u>826,088</u>
11. Material & Adm. Burden			<u>280,870</u>
TOTAL MATERIAL			<u>1,106,958</u>
TOTAL TOOLING COST			<u>\$11,522,681</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

FORWARD SKIRT - TOOLING - E/M
ASSEMBLY OR SYSTEM
TABLE 3.2.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	: 19,926	\$193,681
Component Test Planning	6,376	61,978
(1) Subtotal (A)	26,302	255,659
(2) Direct Distributable	8,417	81,810
Subtotal (B)	34,719	337,469
(3) Training	382	3,712
Subtotal (C)	35,101	341,181
(4) Mfg. Tech.	667	7,876
Subtotal (D)	35,768	349,057
(5) Q&RA	7,020	68,235
Total Mfg. Test Labor	43,788	\$417,292
Material		
(6) Q&RA		2,106
(7) Mfg. Tech.		1,167
Subtotal (E)		3,273
(8) Material & Adm. Burden		1,113
Total Material		4,386
Total Mfg. Test Cost		\$421,678

3.2.1.2 LH₂ Tank

TABLE 3.2.1.2-I

MLLV COST SUMMARY

LH₂ TANK - ENGINE MODULEA ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	12	143								12	143
PROGRAM PLAN.& REPT.	30	358								30	358
INDUSTRIAL RELATIONS	7	63								7	63
ENGINEERING			273	3,229						273	3,229
LAB TECHNICIANS			55	531						55	531
TOOLING			508	4,940						508	4,940
PRODUCTION											
MANUFACTURING TEST			24	234						24	234
MANUFACTURING TECH.			13	151						13	151
Q & R A			140	1,369						140	1,369
FACILITIES											
DIRECT DIST			135	1,310						135	1,310
TRAINING			7	71						7	71
TOTAL DIRECT LABOR	49	564	1,155	11,835						1,204	12,399
MATERIAL		2		743							745
LOGISTIC HARDWARE											
BURDEN				252							252
TOTAL MATERIAL		2		995							997
TOTAL OTHER											
TOTAL COST		566		12,830							13,396

MLLV

PART I

LH₂ TANK - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.1.2-II

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	273		
Logistics			
Laboratory Technician	55		
Production			
Tooling	508		
Manufacturing Test	24		
Q&RA	140		
Facilities			
Manufacturing Technician	13		
Total Direct Labor	1,013		
Program Executive		12	143
Program Planning & Reporting		30	358
Industrial Relations		7	63
Total Labor - Part I		49	564
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			
Total Material			2
TOTAL COST - PART I			566

TABLE 3.2.1.2-III

MLLV PART II COST SUMMARY LH₂ TANK - E/MA ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	150	1,772			123	1,457			273	3,229
LAB TECHNICIANS	30	291			25	240			55	531
TOOLING					508	4,940			508	4,940
PRODUCTION										
MANUFACTURING TEST							24	234	24	234
MANUFACTURING TECH.					12	144	1	7	13	151
Q & RA	6	58			128	1,248	6	63	140	1,369
DIRECT DIST					127	1,235	8	75	135	1,310
TRAINING					7	68		3	7	71
TOTAL DIRECT LABOR	186	2,121			930	9,332	39	382	1,155	11,835
MATERIAL										
LAB. TECHNICIANS		63				52				115
TOOLING						572				572
PRODUCTION										
MFG. TECHNICIANS						12		1		13
Q&RA		2				39		2		43
SUBTOTAL		65				675		3		743
MAT. & ADM. BURDEN		22				229		1		252
TOTAL MATERIAL		87				904		4		995
TOTAL PART II COST		2,208				10,236		386		12,830

MLLV
NON-RECURRING COSTS
PART II-A LH2 TANK - E/M

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.2.1.2-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>150,000</u>	<u>1,771,500</u>
1. Laboratory Technicians	<u>30,000</u>	<u>291,600</u>
Subtotal	<u>180,000</u>	<u>2,063,100</u>
2. Q&RA	<u>6,000</u>	<u>58,320</u>
TOTAL ENGINEERING LABOR	<u>186,000</u>	<u>2,121,420</u>
MATERIAL		
3. Laboratory Technicians		<u>63,000</u>
4. Q&RA		<u>1,800</u>
Subtotal		<u>64,800</u>
5. Material and Adm. Burden		<u>22,032</u>
TOTAL MATERIAL		<u>86,832</u>
TOTAL ENGINEERING COST		<u>2,208,252</u>

MLLV
NON-RECURRING COSTS

LH₂ TANK - E/M

PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.1.2-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>123,392</u>	<u>1,457,260</u>
1. Lab. Tech.		<u>24,678</u>	<u>239,874</u>
TOTAL ENGR.		<u>148,070</u>	<u>1,697,134</u>
Fabrication and Erection			
Fab. & Assembly	<u>364,581</u>		<u>3,543,727</u>
Misc. Charges 7.8%	<u>28,437</u>		<u>276,411</u>
Maintain & Add			
In Scope Changes 1.1%	<u>4,010</u>		<u>38,980</u>
SUBTOTAL (A)	<u>397,029</u>		<u>3,859,118</u>
2. Tool and Production Planning	<u>111,168</u>		<u>1,080,553</u>
SUBTOTAL (B)	<u>508,197</u>		<u>4,939,681</u>
3. Direct Distributable	<u>127,049</u>		<u>1,234,917</u>
SUBTOTAL (C)	<u>635,246</u>		<u>6,174,588</u>
4. Training	<u>6,988</u>		<u>67,920</u>
SUBTOTAL (D)	<u>642,234</u>		<u>6,242,508</u>
5. Q&RA	<u>128,447</u>		<u>1,248,501</u>
6. Manufacturing Tech.	<u>12,202</u>		<u>144,110</u>
TOTAL PRODUCTION LABOR	<u>782,883</u>		<u>7,635,119</u>
MATERIAL			
7. Tooling			<u>571,867</u>
8. Lab. Tech.			<u>51,824</u>
9. Q&RA			<u>38,534</u>
10. Manufacturing Tech.			<u>12,202</u>
MATERIAL SUBTOTAL (E)			<u>674,427</u>
11. Material & Adm. Burden			<u>229,305</u>
TOTAL MATERIAL			<u>903,732</u>
TOTAL TOOLING COST			<u>10,235,985</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
LH₂ TANK-TOOLING - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	18,229	177,186
Component Test Planning	5,833	56,699
(1) Subtotal (A)	24,062	233,885
(2) Direct Distributable	7,700	74,843
Subtotal (B)	31,762	308,728
(3) Training	349	3,395
Subtotal (C)	32,111	312,123
(4) Mfg. Tech.	610	7,205
Subtotal (D)	32,721	319,328
(5) Q&RA	6,422	62,424
Total Mfg. Test Labor	39,143	381,752
Material		
(6) Q&RA		1,927
(7) Mfg. Tech.		1,068
Subtotal (E)		2,995
(8) Material & Adm. Burden		1,018
Total Material		4,013
Total Mfg. Test Cost		385,765

3.2.1.3 LOX Tank

TABLE 3.2.1.3-I

MLLV COST SUMMARY

LOX TANK - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	6	71								6	71
PROGRAM PLAN.& REPT.	15	177								15	177
INDUSTRIAL RELATIONS	3	31								3	31
ENGINEERING			201	2,376						201	2,376
LAB TECHNICIANS			40	390						40	390
TOOLING			189	1,834						189	1,834
PRODUCTION											
MANUFACTURING TEST			9	87						9	87
MANUFACTURING TECH.			5	57						5	57
Q & R A			56	545						56	545
FACILITIES											
DIRECT DIST			50	486						50	486
TRAINING			3	26						3	26
TOTAL DIRECT LABOR	24	279	553	5,801						577	6,080
MATERIAL				347							347
LOGISTIC HARDWARE											
BURDEN				117							117
TOTAL MATERIAL				464							464
TOTAL OTHER											
TOTAL COST		279		6,265							6,544

MLLV

PART I

LOX TANK - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	201		
Logistics			
Laboratory Technician	40		
Production			
Tooling	189		
Manufacturing Test	9		
Q&RA	56		
Facilities			
Manufacturing Technician	5		
Total Direct Labor	500		
Program Executive		6	71
Program Planning & Reporting		15	177
Industrial Relations		3	31
Total Labor - Part I		24	279
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			279

TABLE 3.2.1.3-III

MLLV PART II COST SUMMARY LOX TANK - E/M

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	150	1,772			51	604			201	2,376
LAB TECHNICIANS	30	291			10	99			40	390
TOOLING					189	1,834			189	1,834
PRODUCTION										
MANUFACTURING TEST							9	87	9	87
MANUFACTURING TECH.					5	54		3	5	57
Q & RA	6	58			48	464	2	23	56	545
DIRECT DIST					47	458	3	28	50	486
TRAINING					3	25		1	3	26
TOTAL DIRECT LABOR	186	2,121			352	3,538	15	142	553	5,801
MATERIAL										
LAB. TECHNICIANS		63				22				85
TOOLING						237				237
PRODUCTION										
MFG. TECHNICIANS						8				8
Q&RA		22				14	1			17
SUBTOTAL		65				281	1			347
MAT. & ADM. BURDEN		22				25				117
TOTAL MATERIAL		87				376	1			464
TOTAL PART II COST		2,208				3,914	143			6,265

MLLV
NON-RECURRING COSTS
PART II-A LOX TANK - E/M

ASSEMBLY OR SYSTEM
DESIGN ENGINEERING
TABLE 3.2.1.3-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>150,000</u>	<u>1,771,500</u>
1. Laboratory Technicians	<u>30,000</u>	<u>291,600</u>
Subtotal	<u>180,000</u>	<u>2,063,100</u>
2. Q&RA	<u>6,000</u>	<u>58,320</u>
TOTAL ENGINEERING LABOR	<u>186,000</u>	<u>2,121,420</u>
MATERIAL		
3. Laboratory Technicians		<u>63,000</u>
4. Q&RA		<u>1,800</u>
Subtotal		<u>64,800</u>
5. Material and Adm. Burden		<u>22,032</u>
TOTAL MATERIAL		<u>86,832</u>
TOTAL ENGINEERING COST		<u>2,208,252</u>

MLIV
NON-RECURRING COSTS

LOX TANK - E/M
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.1.3-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>51,119</u>	<u>603,715</u>
1. Lab. Tech.		<u>10,224</u>	<u>99,375</u>
TOTAL ENGR.		<u>61,343</u>	<u>703,090</u>
Fabrication and Erection			
Fab. & Assembly	<u>135,381</u>		<u>1,315,903</u>
Misc. Charges 7.8%	<u>10,560</u>		<u>102,640</u>
Maintain & Add			
In Scope Changes 1.1%	<u>1,489</u>		<u>14,474</u>
SUBTOTAL (A)	<u>147,430</u>		<u>1,433,017</u>
2. Tool and Production Planning	<u>41,280</u>		<u>401,245</u>
SUBTOTAL (B)	<u>188,710</u>		<u>1,834,262</u>
3. Direct Distributable	<u>47,178</u>		<u>458,565</u>
SUBTOTAL (C)	<u>235,888</u>		<u>2,292,827</u>
4. Training	<u>2,594</u>		<u>25,220</u>
SUBTOTAL (D)	<u>238,482</u>		<u>2,318,047</u>
5. Q&RA	<u>47,696</u>		<u>463,609</u>
6. Manufacturing Tech.	<u>4,531</u>		<u>53,512</u>
TOTAL PRODUCTION LABOR	<u>290,709</u>		<u>2,835,168</u>
MATERIAL			
7. Tooling			<u>236,917</u>
8. Lab. Tech.			<u>21,470</u>
9. Q&RA			<u>14,309</u>
10. Manufacturing Tech.			<u>7,929</u>
MATERIAL SUBTOTAL (E)			<u>280,625</u>
11. Material & Adm. Burden			<u>95,413</u>
TOTAL MATERIAL			<u>376,038</u>
TOTAL TOOLING COST			<u>3,914,296</u>

MLIV
 PART IIB
 MANUFACTURING
 MANUFACTURING TEST
LOX TANK-TOOLING - E/M
 ASSEMBLY OR SYSTEM
 TABLE 3.2.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	6,769	65,795
Component Test Planning	2,166	21,054
(1) Subtotal (A)	8,935	86,849
(2) Direct Distributable	2,859	27,791
Subtotal (B)	11,794	114,640
(3) Training	130	1,261
Subtotal (C)	11,924	115,901
(4) Mfg. Tech.	227	2,675
Subtotal (D)	12,151	118,576
(5) Q&RA	2,385	23,179
Total Mfg. Test Labor	<u>14,536</u>	<u>141,755</u>
Material		
(6) Q&RA		715
(7) Mfg. Tech.		396
Subtotal (E)		1,111
(8) Material & Adm. Burden		378
Total Material		<u>1,489</u>
Total Mfg. Test Cost		<u>143,244</u>

3.2.1.4 Tunnels

TABLE 3.2.1.4-I

MLLV COST SUMMARY

TUNNELS - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	17								1	17
PROGRAM PLAN.& REPT.	4	46								4	46
INDUSTRIAL RELATIONS	1	8								1	8
ENGINEERING			69	817						69	817
LAB TECHNICIANS			14	135						14	135
TOOLING			34	329						34	329
PRODUCTION											
MANUFACTURING TEST			2	16						2	16
MANUFACTURING TECH.			1	10						1	10
Q & R A			11	111						11	111
FACILITIES											
DIRECT DIST			9	87						9	87
TRAINING				5							5
TOTAL DIRECT LABOR	6	71	140	1,150						146	1,581
MATERIAL				83							83
LOGISTIC HARDWARE											
BURDEN				28							28
TOTAL MATERIAL				111							111
TOTAL OTHER											
TOTAL COST		71		1,621							\$1,692

MLLV

PART I

TUNNELS - ENGINE MODULE
ASSEMBLY OR SYSTEM

TABLE 3.2.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering 69			
Logistics			
Laboratory Technician 14			
Production			
Tooling 34			
Manufacturing Test 2			
Q&RA 11			
Facilities			
Manufacturing Technician 1			
Total Direct Labor		<u>131</u>	
Program Executive		1	17
Program Planning & Reporting		4	46
Industrial Relations		1	8
Total Labor - Part I		<u>6</u>	<u>71</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>\$71</u>

TABLE 3.2.1.4-III

TUNNELS - ENGINE MODULE

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	60	709			9	108			69	817
LAB TECHNICIANS	12	117			2	18			14	135
TOOLING					34	329			34	329
PRODUCTION										
MANUFACTURING TEST							2	16	2	16
MANUFACTURING TECH.					1	10			1	10
Q & RA	2	23			9	83		5	11	111
DIRECT DIST					8	82	1	5	9	87
TRAINING						5				5
TOTAL DIRECT LABOR	74	849			63	635	3	26	140	1,510
MATERIAL										
LAB. TECHNICIANS		25				4				29
TOOLING						43				43
PRODUCTION										
MFG. TECHNICIANS						1				1
Q&RA		7				3				10
SUBTOTAL		32				51				83
MAT. & ADM. BURDEN		11				17				28
TOTAL MATERIAL		43				68				111
TOTAL PART II COST		\$892				\$703		\$26		\$1,621

MLLV
NON-RECURRING COSTS
PART II-A TUNNELS - ENGINE MODULE

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.2.1.4-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>60,000</u>	<u>\$708,600</u>
1. Laboratory Technicians	<u>12,000</u>	<u>116,640</u>
Subtotal	<u>72,000</u>	<u>\$825,240</u>
2. Q&RA	<u>2,400</u>	<u>23,328</u>
TOTAL ENGINEERING LABOR	<u>74,400</u>	<u>848,568</u>
 MATERIAL		
3. Laboratory Technicians		<u>\$ 25,200</u>
4. Q&RA		<u>7,200</u>
Subtotal		<u>\$ 32,400</u>
5. Material and Adm. Burden		<u>11,016</u>
TOTAL MATERIAL		<u>\$ 43,416</u>
TOTAL ENGINEERING COST		<u>\$891,984</u>

MLIV
NON-RECURRING COSTS

TUNNELS - ENGINE MODULE
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.1.4-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>9,185</u>	<u>\$108,475</u>
1. Lab. Tech.		<u>1,837</u>	<u>17,856</u>
TOTAL ENGR.		<u>11,022</u>	<u>\$126,331</u>
Fabrication and Erection			
Fab. & Assembly	<u>24,324</u>		<u>236,429</u>
Misc. Charges 7.8%	<u>1,897</u>		<u>18,441</u>
Maintain & Add			
In Scope Changes 1.1%	<u>268</u>		<u>2,600</u>
SUBTOTAL (A)	<u>26,489</u>		<u>257,470</u>
2. Tool and Production Planning	<u>7,417</u>		<u>72,091</u>
SUBTOTAL (B)	<u>33,906</u>		<u>329,561</u>
3. Direct Distributable	<u>8,476</u>		<u>82,390</u>
SUBTOTAL (C)	<u>42,382</u>		<u>411,951</u>
4. Training	<u>466</u>		<u>4,530</u>
SUBTOTAL (D)	<u>42,848</u>		<u>416,481</u>
5. Q&RA	<u>8,570</u>		<u>83,296</u>
6. Manufacturing Tech.	<u>814</u>		<u>9,615</u>
TOTAL PRODUCTION LABOR	<u>52,232</u>		<u>\$509,392</u>
MATERIAL			
7. Tooling			<u>\$ 42,568</u>
8. Lab. Tech.			<u>3,858</u>
9. Q&RA			<u>2,571</u>
10. Manufacturing Tech.			<u>1,425</u>
MATERIAL SUBTOTAL (E)			<u>50,422</u>
11. Material & Adm. Burden			<u>17,143</u>
TOTAL MATERIAL			<u>67,565</u>
TOTAL TOOLING COST			<u>\$703,288</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

TUNNELS - TOOLING

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,216	\$ 11,820
Component Test Planning	389	3,782
(1) Subtotal (A)	1,605	15,602
(2) Direct Distributable	514	4,992
Subtotal (B)	2,119	20,594
(3) Training	23	226
Subtotal (C)	2,142	20,820
(4) Mfg. Tech.	41	479
Subtotal (D)	2,183	21,299
(5) Q&RA	428	4,164
Total Mfg. Test Labor	<u>2,611</u>	<u>\$ 25,463</u>
Material		
(6) Q&RA		129
(7) Mfg. Tech.		71
Subtotal (E)		200
(8) Material & Adm. Burden		68
Total Material		<u>268</u>
Total Mfg. Test Cost		<u>\$ 25,731</u>

3.2.1.5 Thrust Structure

TABLE 3.2.1.5-I
MLLV COST SUMMARY

THRUST STRUCTURE - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	15	177								15	177
PROGRAM PLAN.& REPT.	38	444								38	444
INDUSTRIAL RELATIONS	8	79								8	79
ENGINEERING			264	3,121						264	3,121
LAB TECHNICIANS			53	514						53	514
TOOLING			699	6,791						699	6,791
PRODUCTION											
MANUFACTURING TEST			33	322						33	322
MANUFACTURING TECH.			18	208						18	208
Q & R A			189	1,831						189	1,831
FACILITIES											
DIRECT DIST			186	1,801						186	1,801
TRAINING			10	98						10	98
TOTAL DIRECT LABOR	61	700	1,452	14,686						1,513	15,386
MATERIAL		2		1,075							1,077
LOGISTIC HARDWARE											
BURDEN				365							365
TOTAL MATERIAL		2		1,440							1,442
TOTAL OTHER											
TOTAL COST		702		16,126							16,828

MLLV

PART I

THRUST STRUCTURE - ENGINE MODULE
ASSEMBLY OR SYSTEM

TABLE 3.2.1.5-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering	264		
Logistics			
Laboratory Technician	53		
Production			
Tooling	699		
Manufacturing Test	44		
Q&RA	189		
Facilities			
Manufacturing Technician	<u>18</u>		
Total Direct Labor	<u>1,256</u>		
Program Executive		15	177
Program Planning & Reporting		38	444
Industrial Relations		<u>8</u>	<u>79</u>
Total Labor - Part I		<u>61</u>	<u>700</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			1
Material Subtotal			2
Material & Administrative Burden			
Total Material			<u>2</u>
TOTAL COST - PART I			\$ <u>702</u>

TABLE 3.2.1.5-III
MLLV PART II COST SUMMARY

THRUST STRUCTURE - ENGINE MODULE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	75	886			189	2,235			264	3,121
LAB TECHNICIANS	15	146			38	368			53	514
TOOLING					699	6,791			699	6,791
PRODUCTION										
MANUFACTURING TEST							33	322	33	322
MANUFACTURING TECH.					17	198	1	10	18	208
Q&RA	3	29			177	1,716	9	86	189	1,831
DIRECT DIST					175	1,698	11	103	186	1,801
TRAINING					10	93		5	10	98
TOTAL DIRECT LABOR	93	1,061			1,303	13,100	54	525	1,452	14,686
MATERIAL										
LAB. TECHNICIANS		31				80				111
TOOLING						877				877
PRODUCTION										
MFG. TECHNICIANS						29		1		30
Q&RA		1				53		3		57
SUBTOTAL		32				1,039		4		1,075
MAT. & ADM. BURDEN		11				353		1		365
TOTAL MATERIAL		43				1,392		15		1,440
TOTAL PART II COST		1,104				14,492		530		16,126

MLLV
NON-RECURRING COSTS
PART II-A THRUST STRUCTURE - ENGINE MODULE
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.2.1.5-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>75,000</u>	\$ <u>885,750</u>
1. Laboratory Technicians		<u>15,000</u>	<u>145,800</u>
Subtotal		<u>90,000</u>	1, <u>031,550</u>
2. Q&RA		<u>3,000</u>	<u>29,160</u>
TOTAL ENGINEERING LABOR		<u>93,000</u>	1, <u>060,710</u>
MATERIAL			
3. Laboratory Technicians			<u>31,500</u>
4. Q&RA			<u>900</u>
Subtotal			<u>32,400</u>
5. Material and Adm. Burden			<u>11,016</u>
TOTAL MATERIAL			<u>43,416</u>
TOTAL ENGINEERING COST			1, <u>104,126</u>

MLLV
NON-RECURRING COSTS

THRUST STRUCTURE - ENGINE MODULE
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.1.5-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>189,264</u>	<u>\$2,235,208</u>
1. Lab. Tech.		<u>37,853</u>	<u>367,929</u>
TOTAL ENGR.		<u>227,117</u>	<u>2,603,137</u>
Fabrication and Erection			
Fab. & Assembly	<u>501,228</u>		<u>4,871,936</u>
Misc. Charges 7.8%	<u>39,096</u>		<u>380,010</u>
Maintain & Add			
In Scope Changes 1.1%	<u>5,514</u>		<u>53,591</u>
SUBTOTAL (A)	<u>545,838</u>		<u>5,305,537</u>
2. Tool and Production Planning	<u>152,834</u>		<u>1,485,550</u>
SUBTOTAL (B)	<u>698,672</u>		<u>6,791,087</u>
3. Direct Distributable	<u>174,668</u>		<u>1,697,772</u>
SUBTOTAL (C)	<u>873,340</u>		<u>8,488,859</u>
4. Training	<u>9,607</u>		<u>93,377</u>
SUBTOTAL (D)	<u>882,947</u>		<u>8,582,236</u>
5. Q&RA	<u>176,589</u>		<u>1,716,447</u>
6. Manufacturing Tech.	<u>16,776</u>		<u>198,123</u>
TOTAL PRODUCTION LABOR	<u>1,076,312</u>		<u>\$ 10,496,806</u>
MATERIAL			
7. Tooling			<u>\$ 877,149</u>
8. Lab. Tech.			<u>79,491</u>
9. Q&RA			<u>52,977</u>
10. Manufacturing Tech.			<u>29,358</u>
MATERIAL SUBTOTAL (E)			<u>1,038,975</u>
11. Material & Adm. Burden			<u>353,252</u>
TOTAL MATERIAL			<u>1,392,227</u>
TOTAL TOOLING COST			<u>\$ 14,492,170</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

THRUST STRUCTURE - TOOLING - ENGINE MODULE

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.1.5-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	25,061	\$243,593
Component Test Planning	8,020	77,950
(1) Subtotal (A)	33,081	321,543
(2) Direct Distributable	10,586	102,893
Subtotal (B)	43,667	424,436
(3) Training	480	4,669
Subtotal (C)	44,147	429,105
(4) Mfg. Tech.	839	9,905
Subtotal (D)	44,986	439,010
(5) Q&RA	8,829	85,821
Total Mfg. Test Labor	53,815	524,831
Material		
(6) Q&RA		2,649
(7) Mfg. Tech.		1,468
Subtotal (E)		4,117
(8) Material & Adm. Burden		1,400
Total Material		5,517
Total Mfg. Test Cost		\$530,348

3.2.1.6 Structure Assembly

TABLE 3.2.1.6-I

MLLV COST SUMMARY

STRUCTURE ASSEMBLY - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	9								1	9
PROGRAM PLAN. & REPT.	2	26								2	26
INDUSTRIAL RELATIONS		4									4
ENGINEERING			60	709						60	709
LAB TECHNICIANS			12	117						12	117
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2	23						2	23
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	3	39	74	849						77	888
MATERIAL				32							32
LOGISTIC HARDWARE											
BURDEN				11							11
TOTAL MATERIAL				43							43
TOTAL OTHER											
TOTAL COST		39		892							931

MLLV

PART I

STRUCTURE ASSEMBLY - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.1.6-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	60		
Logistics			
Laboratory Technician	12		
Production			
Tooling			
Manufacturing Test			
Q&RA	2		
Facilities			
Manufacturing Technician			
	<u>74</u>		
Total Direct Labor			
Program Executive			9
Program Planning & Reporting			26
Industrial Relations			<u>4</u>
Total Labor - Part I		<u>3</u>	<u>39</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			<u></u>
TOTAL COST - PART I			<u>39</u>

TABLE 3.2.1.6-III

MLLV PART II COST SUMMARY STRUCTURE ASSEMBLY - E/M

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	60	709							60	709
LAB TECHNICIANS	12	117							12	117
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q&RA	2	23							2	23
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	74	849							74	849
MATERIAL										
LAB. TECHNICIANS		25								25
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q&RA		7								7
SUBTOTAL		32								32
MAT. & ADM. BURDEN		11								11
TOTAL MATERIAL		43								43
TOTAL PART II COST		892								892

MLLV
NON-RECURRING COSTS
PART II-A STRUCTURES - E/M
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	<u>TABLE 3.2.1.6-IV</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>60,000</u>	<u>708,600</u>
1. Laboratory Technicians		<u>12,000</u>	<u>116,640</u>
Subtotal		<u>72,000</u>	<u>825,240</u>
2. Q&RA		<u>2,400</u>	<u>23,328</u>
TOTAL ENGINEERING LABOR		<u>74,400</u>	<u>848,568</u>
MATERIAL			
3. Laboratory Technicians			<u>25,200</u>
4. Q&RA			<u>7,200</u>
Subtotal			<u>32,400</u>
5. Material and Adm. Burden			<u>11,016</u>
TOTAL MATERIAL			<u>43,416</u>
TOTAL ENGINEERING COST			<u>891,984</u>

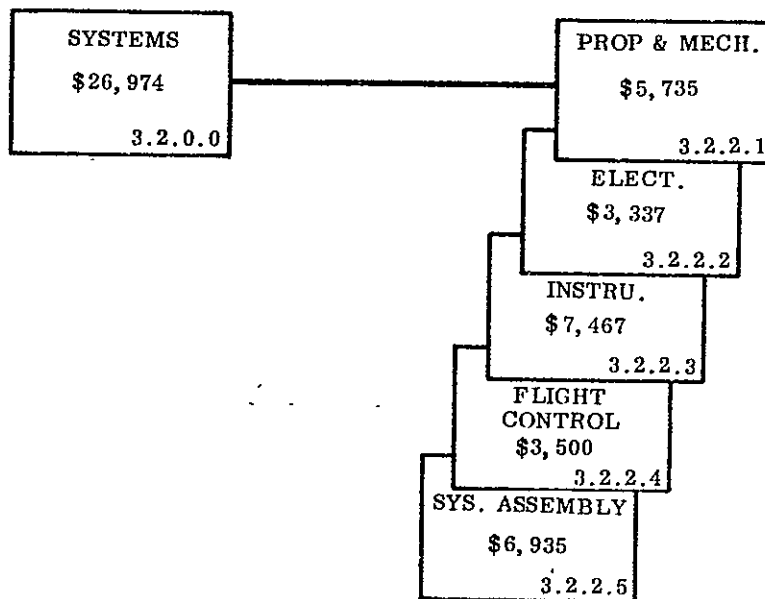
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3.2.2 Systems - Injection Stage - Engine Module

The Get Ready Cost for the system components of the Injection Stage - Engine Module are displayed in Figure 3.2.2.0-1. The cost details of the system components are contained in the appropriate subparagraphs, as indicated.

Table 3.2.2.0-I is a total Get Ready Cost of these systems.

These costs are comprised of basic (or non-recurring) engineering costs required to produce the basic tooling, fabrication and assembly of tooling, and basic article design including all engineering such as manufacturing liaison and coordination required to produce the first article. These costs are non-recurring in that they are experienced once during the production life of a model.



NOTES:-----ALTERNATE SYSTEMS.
 DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 3.2.2.0-1 MLLV INJECTION STAGE ENGINE MODULE SYSTEMS COSTS
 GET READY, "A" COSTS

SYSTEMS - ENGINE MODULE

TABLE 3.2.2.0-I
MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	25	298								25	298
PROGRAM PLAN:& REPT.	65	754								65	754
INDUSTRIAL RELATIONS	15	133								13	133
ENGINEERING			1,546	18,252						1,546	18,252
LAB TECHNICIANS			309	3,005						309	3,005
TOOLING			169	1,636						169	1,636
PRODUCTION											
MANUFACTURING TEST			5	52						5	52
MANUFACTURING TECH.			5	48						5	48
Q & R A			104	1,012						104	1,012
FACILITIES											
DIRECT DIST.			45	426						45	426
TRAINING			1	23						1	23
TOTAL DIRECT LABOR	105	1,185	2,184	24,454						2,289	25,639
MATERIAL		1		997							998
LOGISTIC HARDWARE											
BURDEN				337							337
TOTAL MATERIAL		1		1,334							1,335
TOTAL OTHER											
TOTAL COST		1,186		25,788							26,974

3.2.2.1 Propulsion/Mechanical System

TABLE 3.2.2.1-I
MLLV COST SUMMARY

PROPULSION & MECHANICAL SYSTEM - EM

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	63								5	63
PROGRAM PLAN.& REPT.	14	161								14	161
INDUSTRIAL RELATIONS	3	28								3	28
ENGINEERING			313	3,701						313	3,701
LAB TECHNICIANS			63	609						63	609
TOOLING			50	482						50	482
PRODUCTION											
MANUFACTURING TEST			2	23						2	23
MANUFACTURING TECH.			1	14						1	14
Q & R A			26	245						26	245
FACILITIES											
DIRECT DIST			13	128						13	128
TRAINING				7							7
TOTAL DIRECT LABOR	22	252	468	5,209						490	5,461
MATERIAL		1		204							205
LOGISTIC HARDWARE											
BURDEN				69							69
TOTAL MATERIAL		1		273							274
TOTAL OTHER											
TOTAL COST		253		5,482							\$5,735

MLLV
NON-RECURRING

PART I
PROPULSION & MECHANICAL SYSTEM - EM
ASSEMBLY OR SYSTEM

TABLE 3.2.2.1-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	313		
Logistics			
Laboratory Technician	63		
Production			
Tooling	50		
Manufacturing Test	2		
Q&RA	26		
Facilities			
Manufacturing Technician	1		
Total Direct Labor	455		
Program Executive		5	63
Program Planning & Reporting		14	161
Industrial Relations		3	28
Total Labor - Part I		22	252
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			1
Material Subtotal			1
Material & Administrative Burden			
Total Material			1
TOTAL COST - PART I			\$253

TABLE 3.2.2.1-III
MLLV PART II COST SUMMARY

PROPULSION & MECHANICAL SYSTEM - EM

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	300	3,543			13	158			313	3,701
LAB TECHNICIANS	60	583			3	26			63	609
TOOLING					50	482			50	482
PRODUCTION										
MANUFACTURING TEST							2	23	2	23
MANUFACTURING TECH.					1	14			1	14
Q & RA	12	117			13	122	1	6	26	245
DIRECT DIST					12	120	1	8	13	128
TRAINING						7				7
TOTAL DIRECT LABOR	372	4,243			92	929	4	37	468	5,209
MATERIAL										
LAB. TECHNICIANS		126				6				132
TOOLING						62				62
PRODUCTION										
MFG. TECHNICIANS						2				2
Q&RA		4				4				8
SUBTOTAL		130				74				204
MAT. & ADM. BURDEN		44				25				69
TOTAL MATERIAL		174				99				273
TOTAL PART II COST		\$4,417				\$1,028		\$ 37		\$5,482

MLLV
 NON-RECURRING COSTS
 PART II-A PROPULSION & MECHANICAL SYSTEM - EM
 ASSEMBLY OR SYSTEM
 DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.2.2.1-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>300,000</u>	<u>\$3,543,000</u>
1. Laboratory Technicians		<u>60,000</u>	<u>583,200</u>
Subtotal		<u>360,000</u>	<u>4,126,200</u>
2. Q&RA		<u>12,000</u>	<u>116,640</u>
TOTAL ENGINEERING LABOR		<u>372,000</u>	<u>\$4,242,840</u>
MATERIAL			
3. Laboratory Technicians			<u>126,000</u>
4. Q&RA			<u>3,600</u>
Subtotal			<u>129,600</u>
5. Material and Adm. Burden			<u>44,064</u>
TOTAL MATERIAL			<u>\$ 173,664</u>
TOTAL ENGINEERING COST			<u>\$4,416,504</u>

MLLV
NON-RECURRING COSTS

PROPULSION & MECHANICAL SYSTEM - EM
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.2.1-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>13,421</u>	<u>158,502</u>
1. Lab. Tech.		<u>2,684</u>	<u>26,090</u>
TOTAL ENGR.		<u>16,105</u>	<u>184,592</u>
Fabrication and Erection			
Fab. & Assembly	<u>35,545</u>		<u>345,497</u>
Misc. Charges 7.8%	<u>2,773</u>		<u>26,949</u>
Maintain & Add			
In Scope Changes 1.1%	<u>391</u>		<u>3,800</u>
SUBTOTAL (A)	<u>38,709</u>		<u>376,246</u>
2. Tool and Production Planning	<u>10,838</u>		<u>105,348</u>
SUBTOTAL (B)	<u>49,547</u>		<u>481,594</u>
3. Direct Distributable	<u>12,387</u>		<u>120,398</u>
SUBTOTAL (C)	<u>61,934</u>		<u>601,992</u>
4. Training	<u>681</u>		<u>6,621</u>
SUBTOTAL (D)	<u>62,615</u>		<u>608,613</u>
5. Q&RA	<u>12,523</u>		<u>121,723</u>
6. Manufacturing Tech.	<u>1,190</u>		<u>14,049</u>
TOTAL PRODUCTION LABOR	<u>76,328</u>		<u>\$ 744,385</u>
MATERIAL			
7. Tooling			<u>\$ 62,204</u>
8. Lab. Tech.			<u>5,636</u>
9. Q&RA			<u>3,757</u>
10. Manufacturing Tech.			<u>2,083</u>
MATERIAL SUBTOTAL (E)			<u>73,680</u>
11. Material & Adm. Burden			<u>25,051</u>
TOTAL MATERIAL			<u>98,731</u>
TOTAL TOOLING COST			<u>\$1,027,708</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

PROPULSION & MECHANICAL SYSTEM TOOLING -- EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.2.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,777	\$ 17,272
Component Test Planning	<u>569</u>	<u>5,527</u>
(1) Subtotal (A)	2,346	22,799
(2) Direct Distributable	<u>751</u>	<u>7,295</u>
Subtotal (B)	3,097	30,094
(3) Training	<u>34</u>	<u>330</u>
Subtotal (C)	3,131	30,424
(4) Mfg. Tech.	<u>59</u>	<u>702</u>
Subtotal (D)	3,190	31,126
(5) Q&RA	<u>626</u>	<u>6,085</u>
Total Mfg. Test Labor	<u><u>3,816</u></u>	\$ <u><u>37,211</u></u>
Material		
(6) Q&RA		188
(7) Mfg. Tech.		<u>104</u>
Subtotal (E)		292
(8) Material & Adm. Burden		<u>99</u>
Total Material		<u><u>391</u></u>
Total Mfg. Test Cost		\$ <u><u>37,602</u></u>

3.2.2.2 Electrical System

TABLE 3.2.2.2-I
MLLV COST SUMMARY

ELECTRICAL SYSTEM - E/M

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	36								3	36
PROGRAM PLAN.& REPT.	8	92								8	92
INDUSTRIAL RELATIONS	2	16								2	16
ENGINEERING			186	2,197						186	2,197
LAB TECHNICIANS			37	362						37	362
TOOLING			22	215						22	215
PRODUCTION											
MANUFACTURING TEST			1	10						1	10
MANUFACTURING TECH.			1	7						1	7
Q & RA			13	128						13	128
FACILITIES											
DIRECT DIST			7	57						7	57
TRAINING				3							3
TOTAL DIRECT LABOR	13	144	266	2,979						280	3,123
MATERIAL				160							160
LOGISTIC HARDWARE											
BURDEN				54							54
TOTAL MATERIAL				214							214
TOTAL OTHER											
TOTAL COST		144		3,193							\$3,337

MLLV

PART I

ELECTRICAL - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.2.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	186		
Logistics			
Laboratory Technician	37		
Production			
Tooling	22		
Manufacturing Test	1		
Q&RA	13		
Facilities			
Manufacturing Technician	1		
Total Direct Labor	260		
Program Executive		3	36
Program Planning & Reporting		8	92
Industrial Relations		2	16
Total Labor - Part I		13	\$144
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			\$144

ELECTRICAL SYSTEM - E/M

TABLE 3.2.2.2-III

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	180	2,126			6	71			186	2,197
LAB TECHNICIANS	36	350			1	12			37	362
TOOLING					22	215			22	215
PRODUCTION										
MANUFACTURING TEST							1	10	1	10
MANUFACTURING TECH.					1	6		1	1	7
Q & RA	7	70			6	55		3	13	128
DIRECT DIST					6	54	1	3	7	57
TRAINING						3				3
TOTAL DIRECT LABOR	223	2,546			41	416	2	17	266	\$2,979
MATERIAL										
LAB. TECHNICIANS		76				3				79
TOOLING						77				77
PRODUCTION										
MFG. TECHNICIANS						1				1
Q&RA		2				1				3
SUBTOTAL		78				82				160
MAT. & ADM. BURDEN		26				28				54
TOTAL MATERIAL		104				110				214
TOTAL PART II COST		\$2,650				\$526		\$ 17		\$3,193

MLLV
NON-RECURRING COSTS
PART II-A ELECTRICAL SYSTEM - E/M
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.2.2.2-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>180,000</u>	\$ <u>2,125,800</u>
1. Laboratory Technicians		<u>36,000</u>	<u>349,920</u>
Subtotal		<u>216,000</u>	\$ <u>2,475,720</u>
2. Q&RA		<u>7,200</u>	<u>69,984</u>
TOTAL ENGINEERING LABOR		<u>223,200</u>	\$ <u>2,545,704</u>
MATERIAL			
3. Laboratory Technicians			\$ <u>75,600</u>
4. Q&RA			<u>2,160</u>
Subtotal			\$ <u>77,760</u>
5. Material and Adm. Burden			<u>26,438</u>
TOTAL MATERIAL			\$ <u>104,198</u>
TOTAL ENGINEERING COST			\$ <u>2,649,902</u>

AMLIIV
NON-RECURRING COSTS

ELECTRICAL SYSTEM - E/M
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.2.2-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>5,999</u>	<u>70,848</u>
1. Lab. Tech.		<u>1,200</u>	<u>11,662</u>
TOTAL ENGR.		<u>7,199</u>	<u>82,510</u>
Fabrication and Erection			
Fab. & Assembly	<u>15,889</u>		<u>154,441</u>
Misc. Charges 7.8%	<u>1,239</u>		<u>12,046</u>
Maintain & Add			
In Scope Changes 1.1%	<u>175</u>		<u>1,698</u>
SUBTOTAL (A)	<u>17,303</u>		<u>168,185</u>
2. Tool and Production Planning	<u>4,845</u>		<u>47,091</u>
SUBTOTAL (B)	<u>22,148</u>		<u>215,276</u>
3. Direct Distributable	<u>5,537</u>		<u>53,819</u>
SUBTOTAL (C)	<u>27,685</u>		<u>269,095</u>
4. Training	<u>305</u>		<u>2,960</u>
SUBTOTAL (D)	<u>27,990</u>		<u>272,055</u>
5. Q&RA	<u>5,598</u>		<u>54,411</u>
6. Manufacturing Tech.	<u>532</u>		<u>6,279</u>
TOTAL PRODUCTION LABOR	<u>34,120</u>		<u>\$332,745</u>
MATERIAL			
7. Tooling			<u>\$ 77,236</u>
8. Lab. Tech.			<u>2,520</u>
9. Q&RA			<u>1,679</u>
10. Manufacturing Tech.			<u>931</u>
MATERIAL SUBTOTAL (E)			<u>82,366</u>
11. Material & Adm. Burden			<u>28,004</u>
TOTAL MATERIAL			<u>110,370</u>
TOTAL TOOLING COST			<u>\$525,625</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

ELECTRICAL SYSTEM - TOOLING - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.2.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	794	\$ 7,718
Component Test Planning	<u>254</u>	<u>2,469</u>
(1) Subtotal (A)	1,048	10,187
(2) Direct Distributable	<u>335</u>	<u>3,259</u>
Subtotal (B)	1,383	13,446
(3) Training	<u>15</u>	<u>148</u>
Subtotal (C)	1,398	13,594
(4) Mfg. Tech.	<u>27</u>	<u>313</u>
Subtotal (D)	1,425	13,907
(5) Q&RA	<u>280</u>	<u>2,719</u>
Total Mfg. Test Labor	<u>1,705</u>	\$ <u>16,626</u>
Material		
(6) Q&RA		84
(7) Mfg. Tech.		<u>46</u>
Subtotal (E)		130
(8) Material & Adm. Burden		<u>44</u>
Total Material		<u>174</u>
Total Mfg. Test Cost		\$ <u>16,800</u>

3.2.2.3 Instrumentation System

TABLE 3.2.2.3-I

INSTRUMENTATION - E/M

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	7	84								7	84
PROGRAM PLAN.& REPT.	18	209								18	209
INDUSTRIAL RELATIONS	4	37								4	37
ENGINEERING			456	5,381						456	5,381
LAB TECHNICIANS			91	886						91	886
TOOLING			21	203						21	203
PRODUCTION											
MANUFACTURING TEST			1	10						1	10
MANUFACTURING TECH.			1	6						1	6
Q & R A			23	229						23	229
FACILITIES											
DIRECT DIST.			6	54						6	54
TRAINING				3							3
TOTAL DIRECT LABOR	29	330	599	6,772						628	7,102
MATERIAL				273							273
LOGISTIC HARDWARE											
BURDEN				92							92
TOTAL MATERIAL				365							365
TOTAL OTHER											
TOTAL COST		330		7,137							\$7,467

MLLV

PART I

INSTRUMENTATION - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.2.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	456		
Logistics			
Laboratory Technician	91		
Production			
Tooling	21		
Manufacturing Test	1		
Q&RA	23		
Facilities			
Manufacturing Technician	<u>1</u>		
Total Direct Labor	<u>593</u>		
Program Executive		7	84
Program Planning & Reporting		18	209
Industrial Relations		<u>4</u>	<u>37</u>
Total Labor - Part I		<u>29</u>	<u>330</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>\$330</u>

TABLE 3.2.2.3-III

INSTRUMENTATION - E/M

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	450	5,314			6	67			456	5,382
LAB TECHNICIANS	90	875			1	11			91	886
TOOLING					21	203			21	203
PRODUCTION										
MANUFACTURING TEST							1	10	1	10
MANUFACTURING TECH.					1	6			1	6
Q & RA	18	175			5	51		3	23	229
DIRECT DIST					5	51	1	3	6	54
TRAINING						3				3
TOTAL DIRECT LABOR	558	6,364			39	392	2	16	599	\$6,772
MATERIAL										
LAB. TECHNICIANS		189				2				191
TOOLING						73				73
PRODUCTION										
MFG. TECHNICIANS						1				1
Q&RA		6				2				8
SUBTOTAL		195				78				273
MAT. & ADM. BURDEN		66				26				92
TOTAL MATERIAL		261				104				365
TOTAL PART II COST		6,625				\$496		\$ 16		\$7,137

MLLV
NON-RECURRING COSTS
PART II-A INSTRUMENTATION SYSTEM - E/M
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	<u>TABLE 3.2.2.3-IV</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>450,000</u>	\$ <u>5,314,500</u>
1. Laboratory Technicians		<u>90,000</u>	<u>874,800</u>
Subtotal		<u>540,000</u>	\$ <u>6,189,300</u>
2. Q&RA		<u>18,000</u>	<u>174,960</u>
TOTAL ENGINEERING LABOR		<u>558,000</u>	\$ <u>6,364,260</u>
MATERIAL			
3. Laboratory Technicians			\$ <u>189,000</u>
4. Q&RA			<u>5,400</u>
Subtotal			\$ <u>194,400</u>
5. Material and Adm. Burden			<u>66,096</u>
TOTAL MATERIAL			\$ <u>260,496</u>
TOTAL ENGINEERING COST			\$ <u>6,624,756</u>

MLLV
NON-RECURRING COSTS

INSTRUMENTATION SYSTEM - E/M
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.2.3-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		5,669	66,951
1. Lab. Tech.		1,134	11,021
TOTAL ENGR.		6,803	77,972
Fabrication and Erection			
Fab. & Assembly	14,988		145,683
Misc. Charges 7.8%	1,169		11,363
Maintain & Add			
In Scope Changes 1.1%	165		1,602
SUBTOTAL (A)	16,322		158,648
2. Tool and Production Planning	4,570		44,421
SUBTOTAL (B)	20,892		203,069
3. Direct Distributable	5,223		50,767
SUBTOTAL (C)	26,115		253,836
4. Training	287		2,792
SUBTOTAL (D)	26,402		256,628
5. Q&RA	5,280		51,325
6. Manufacturing Tech.	502		5,923
TOTAL PRODUCTION LABOR	32,184		\$ 313,876
MATERIAL			
7. Tooling			\$ 72,858
8. Lab. Tech.			2,381
9. Q&RA			1,584
10. Manufacturing Tech.			879
MATERIAL SUBTOTAL (E)			77,702
11. Material & Adm. Burden			26,419
TOTAL MATERIAL			104,121
TOTAL TOOLING COST			\$ 495,969

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST

INSTRUMENTATION SYSTEM-TOOLING - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.2.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	749	\$ 7,280
Component Test Planning	<u>240</u>	<u>2,329</u>
(1) Subtotal (A)	989	9,609
(2) Direct Distributable	<u>316</u>	<u>3,074</u>
Subtotal (B)	1,305	12,683
(3) Training	<u>14</u>	<u>139</u>
Subtotal (C)	1,319	12,822
(4) Mfg. Tech.	<u>25</u>	<u>295</u>
Subtotal (D)	1,344	13,117
(5) Q&RA	<u>264</u>	<u>2,564</u>
Total Mfg. Test Labor	<u><u>1,608</u></u>	\$ <u><u>15,681</u></u>
Material		
(6) Q&RA		79
(7) Mfg. Tech.		<u>44</u>
Subtotal (E)		123
(8) Material & Adm. Burden		<u>42</u>
Total Material		<u><u>165</u></u>
Total Mfg. Test Cost		\$ <u><u>15,846</u></u>

3.2.2.4 Flight Control System

TABLE 3.2.2.4-I
MLLV COST SUMMARY

FLIGHT CONTROL - E/M

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	37								3	37
PROGRAM PLAN.& REPT.	8	95								8	95
INDUSTRIAL RELATIONS	2	17								2	17
ENGINEERING			141	1,659						141	1,659
LAB TECHNICIANS			28	273						28	273
TOOLING			76	736						76	736
PRODUCTION											
MANUFACTURING TEST			1	9						1	9
MANUFACTURING TECH.			2	21						2	21
Q & R A			24	235						24	235
FACILITIES											
DIRECT DIST.			19	187						19	187
TRAINING			1	10						1	10
TOTAL DIRECT LABOR	13	149	292	3,130						304	3,279
MATERIAL				165							165
LOGISTIC HARDWARE											
BURDEN				56							56
TOTAL MATERIAL				221							221
TOTAL OTHER											
TOTAL COST		149		3,351							\$3,500

MLLV

PART I

FLIGHT CONTROL - E/MASSEMBLY OR SYSTEM

TABLE 3.2.2.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	140		
Logistics			
Laboratory Technician	28		
Production			
Tooling	76		
Manufacturing Test	1		
Q&RA	24		
Facilities			
Manufacturing Technician	2		
Total Direct Labor	271		
Program Executive		3	37
Program Planning & Reporting		8	95
Industrial Relations		2	17
Total Labor - Part I		13	\$149
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			\$149

TABLE 3.2.2.4-III

FLIGHT CONTROL - E/M

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	120	1,417			21	242			141	1,659
LAB TECHNICIANS	24	233			4	40			28	273
TOOLING					76	736			76	736
PRODUCTION										
MANUFACTURING TEST							1	9	1	9
MANUFACTURING TECH.					2	21			2	21
Q & RA	5	47			19	186		2	24	235
DIRECT DIST					19	184		3	19	187
TRAINING					1	10			1	10
TOTAL DIRECT LABOR	149	1,697			142	1,419	1	14	292	3,130
MATERIAL										
LAB. TECHNICIANS		51				9				60
TOOLING						95				95
PRODUCTION										
MFG. TECHNICIANS						3				3
Q&RA		1				6				7
SUBTOTAL		52				113				165
MAT. & ADM. BURDEN		18				38				56
TOTAL MATERIAL		70				151				221
TOTAL PART II COST		\$1,767				\$1,570		\$ 14		\$3,351

MLLV
NON-RECURRING COSTS
PART II-A FLIGHT CONTROL - E/M
ASSEMBLY OR SYSTEM
DESIGN ENGINEERING
TABLE 3.2.2.4-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>120,000</u>	\$ <u>1,417,200</u>
1. Laboratory Technicians	<u>24,000</u>	<u>233,280</u>
Subtotal	<u>144,000</u>	\$ <u>1,650,480</u>
2. Q&RA	<u>4,800</u>	<u>46,656</u>
TOTAL ENGINEERING LABOR	<u>148,800</u>	\$ <u>1,697,136</u>
 MATERIAL		
3. Laboratory Technicians		\$ <u>50,400</u>
4. Q&RA		<u>1,440</u>
Subtotal		\$ <u>51,840</u>
5. Material and Adm. Burden		<u>17,626</u>
TOTAL MATERIAL		\$ <u>69,466</u>
TOTAL ENGINEERING COST		\$ <u>1,766,602</u>

AMLLV
NON-RECURRING COSTS
FLIGHT CONTROL - E/M
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.2.4-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		<u>20,503</u>	<u>242,140</u>
1. Lab. Tech.		<u>4,101</u>	<u>39,858</u>
TOTAL ENGR.		<u>24,604</u>	<u>281,998</u>
Fabrication and Erection			
Fab. & Assembly	<u>54,300</u>		<u>527,796</u>
Misc. Charges 7.8%	<u>4,235</u>		<u>41,168</u>
Maintain & Add			
In Scope Changes 1.1%	<u>597</u>		<u>5,806</u>
SUBTOTAL (A)	<u>59,132</u>		<u>574,770</u>
2. Tool and Production Planning	<u>16,557</u>		<u>160,935</u>
SUBTOTAL (B)	<u>75,689</u>		<u>735,705</u>
3. Direct Distributable	<u>18,922</u>		<u>183,926</u>
SUBTOTAL (C)	<u>94,611</u>		<u>919,631</u>
4. Training	<u>1,041</u>		<u>10,116</u>
SUBTOTAL (D)	<u>95,652</u>		<u>929,747</u>
5. Q&RA	<u>19,131</u>		<u>185,948</u>
6. Manufacturing Tech.	<u>1,817</u>		<u>21,463</u>
TOTAL PRODUCTION LABOR	<u>116,600</u>		<u>\$1,137,158</u>
MATERIAL			
7. Tooling			<u>95,025</u>
8. Lab. Tech.			<u>8,612</u>
9. Q&RA			<u>5,739</u>
10. Manufacturing Tech.			<u>3,180</u>
MATERIAL SUBTOTAL (E)			<u>112,556</u>
11. Material & Adm. Burden			<u>38,269</u>
TOTAL MATERIAL			<u>150,825</u>
TOTAL TOOLING COST			<u>\$1,569,981</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
FLIGHT CONTROL-TOOLING - E/M
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 3.2.2.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	646	\$ 6,279
Component Test Planning	<u>207</u>	<u>2,009</u>
(1) Subtotal (A)	853	8,288
(2) Direct Distributable	<u>273</u>	<u>2,652</u>
Subtotal (B)	1,126	10,940
(3) Training	<u>12</u>	<u>120</u>
Subtotal (C)	1,138	11,060
(4) Mfg. Tech.	<u>22</u>	<u>255</u>
Subtotal (D)	1,160	11,315
(5) Q&RA	<u>228</u>	<u>2,211</u>
Total Mfg. Test Labor	<u><u>1,388</u></u>	\$ <u><u>13,526</u></u>
Material		
(6) Q&RA		68
(7) Mfg. Tech.		<u>38</u>
Subtotal (E)		106
(8) Material & Adm. Burden		<u>36</u>
Total Material		142
Total Mfg. Test Cost		\$ <u><u>13,668</u></u>

3.2.2.5 System Assembly

SYSTEMS ASSEMBLY - E/M

TABLE 3.2.2.5-I

MLLV COST SUMMARY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	7	78								7	78
PROGRAM PLAN.& REPT.	17	197								17	197
INDUSTRIAL RELATIONS	4	35								4	35
ENGINEERING			450	5,314						450	5,314
LAB TECHNICIANS			90	875						90	875
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			18	175						18	175
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	28	310	558	6,364						586	6,674
MATERIAL				195							195
LOGISTIC HARDWARE											
BURDEN				66							66
TOTAL MATERIAL				261							261
TOTAL OTHER											
TOTAL COST		310		6,625							\$6,935

MLLV

PART I

SYSTEMS ASSEMBLY - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.2.5-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	450		
Logistics			
Laboratory Technician	90		
Production			
Tooling			
Manufacturing Test			
Q&RA	18		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>558</u>		
Program Executive		7	78
Program Planning & Reporting		17	197
Industrial Relations		<u>4</u>	35
Total Labor - Part I		<u>28</u>	\$310
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>\$310</u>

TABLE 3.2.2.5-III

SYSTEMS ASSEMBLY - E/M

MLLV PART II COST SUMMARY

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	450	5,314							450	5,314
LAB TECHNICIANS	90	875							90	875
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & RA	18	175							18	175
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	558	6,364							558	6,364
MATERIAL										
LAB. TECHNICIANS		189								189
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q&RA		6								6
SUBTOTAL		195								195
MAT. & ADM. BURDEN		66								66
TOTAL MATERIAL		261								261
TOTAL PART II COST		\$6,625								\$6,625

MLLV
NON-RECURRING COSTS
PART II-A SYSTEMS ASSEMBLY - E/M

ASSEMBLY OR SYSTEM
DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.2.2.5-IV	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		<u>450,000</u>	\$5,314,500
1. Laboratory Technicians		<u>90,000</u>	<u>874,800</u>
Subtotal		<u>540,000</u>	\$6,189,300
2. Q&RA		<u>18,000</u>	<u>174,960</u>
TOTAL ENGINEERING LABOR		<u>558,000</u>	\$6,364,260
MATERIAL			
3. Laboratory Technicians			\$ 189,000
4. Q&RA			<u>5,400</u>
Subtotal			\$ 194,400
5. Material and Adm. Burden			\$ 66,096
TOTAL MATERIAL			\$ <u>260,496</u>
TOTAL ENGINEERING COST			\$6,624,756

3.2.3 Injection Stage Liquid Engines

The Get Ready Costs for the 125K thrust high pressure engines were developed from the parametric cost data supplied by Pratt and Whitney, and are displayed in Table 3.2.3.0-I.

TABLE 3.2.3.0-I

MLLV COST SUMMARY

ENGINE MODULE ENGINES

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				14,000							14,000
LAB TECHNICIANS											
TOOLING				17,200							17,200
PRODUCTION				4,200							4,200
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				35,400							35,400
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									*19,465		*19,465
TOTAL COST				35,400					19,465		54,865

* GSE, Facilities

MLLV
ENGINE MODULE
ENGINES

TABLE 3.2.3.0-II

"A" - COSTS

Engineering	\$14.0M
Test	
Equipment	.5M
Tooling (Basic)	4.9M
Fabrication	<u> </u>
Subtotal	\$19.4M

Production

Tooling (Basic)	\$12.3M
Equipment	3.7M
GSE	<u>6.1M</u>
Subtotal	\$22.1M
Total	<u><u>\$41.5M</u></u>

* 125,000 THRUST

"A" & "B" Costs \$183.0M

MLLV
ENGINE MODULE
LIQUID ENGINE FACILITIES AND EQUIPMENT

TABLE 3.2.3.0-III

	<u>Facilities</u>	<u>Equipment</u>
Non-Recurring		
Injection Stage	\$ 6,962,000	\$ 6,403,000

3.2.4 Ground Support Equipment (GSE) - Injection Stage Engine Module

The Get Ready Cost for the engine module GSE includes:

Test and Checkout Equipment:

- Electrical test station
- Mechanical test station
- Data system test station
- Interconnection equipment
- Checkout auxiliary equipment
- Test, checkout, calibration and maintenance equipment
- Subsystems, test equipment
- Subassemblies and parts test
- Data processing station

Handling and Transportation Equipment:

- Stage handling equipment
- Component handling equipment
- Stage transportation equipment

The Get Ready Costs associated with this equipment is displayed in Table 3.2.4.0-I.

TABLE 3.2.4.0-I

MLLV COST SUMMARY

ENGINE MODULE - GSE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	6	68								6	68
PROGRAM PLAN.& REPT.	15	171								15	171
INDUSTRIAL RELATIONS	3	30								3	30
ENGINEERING											
LAB TECHNICIANS											
TOOLING			363	3,527						363	3,527
PRODUCTION											
MANUFACTURING TEST			17	167						17	167
MANUFACTURING TECH.			9	108						9	108
Q & R A			97	938						97	938
FACILITIES											
DIRECT DIST			96	935						96	935
TRAINING			5	51						5	51
TOTAL DIRECT LABOR	24	269	587	5,726						611	5,995
MATERIAL		1		1,047							1,048
LOGISTIC HARDWARE											
BURDEN				356							356
TOTAL MATERIAL		1		1,403							1,404
TOTAL OTHER											
TOTAL COST		270		7,129							7,399

MLLV
NON-RECURRING
PART I
GSE - E/M
ASSEMBLY OR SYSTEM
TABLE 3.2.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production			
Tooling	363		
Manufacturing Test	17		
Q&RA	97		
Facilities			
Manufacturing Technician	<u>7</u>		
Total Direct Labor	<u>484</u>		
Program Executive		6	68
Program Planning & Reporting		15	171
Industrial Relations		<u>3</u>	<u>30</u>
Total Labor - Part I		<u>24</u>	<u>269</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			1
Material Subtotal			<u>1</u>
Material & Administrative Burden			
Total Material			<u>1</u>
TOTAL COST - PART I			<u>270</u>

TABLE 3.2.4.0-III

MLLV PART II COST SUMMARY

GSE - ENGINE MODULE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					363	3,527			363	3,527
PRODUCTION										
MANUFACTURING TEST							17	167	17	167
MANUFACTURING TECH.					8	103	1	5	9	108
Q&RA					92	892	5	46	97	938
DIRECT DIST					91	882	5	53	96	935
TRAINING					5	49		2	5	51
TOTAL DIRECT LABOR					559	5,453	28	273	587	5,726
MATERIAL										
LAB. TECHNICIANS										
TOOLING						1,002				1,002
PRODUCTION										
MFG. TECHNICIANS						15		1		16
Q&RA						28		1		29
SUBTOTAL						1,045		2		1,047
MAT. & ADM. BURDEN						355		1		356
TOTAL MATERIAL						1,400		3		1,403
TOTAL PART II COST						6,853		276		7,129

MLLV
NON-RECURRING COSTS

GSE - E/M
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.2.4.0-IV

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN			
1. Lab. Tech.			
TOTAL ENGR.			
Fabrication and Erection			(In Thousands)
Fab. & Assembly	260,344		2,531
Misc. Charges	20,307		197
Maintain & Add In Scope Changes	2,864		28
SUBTOTAL (A)	283,515		2,756
2. Tool and Production Planning	79,384		771
SUBTOTAL (B)	362,899		3,527
3. Direct Distributable	90,725		882
SUBTOTAL (C)	453,624		4,409
4. Training	4,990		49
SUBTOTAL (D)	458,614		4,458
5. Q&RA	91,723		892
6. Manufacturing Tech.	8,714		103
TOTAL PRODUCTION LABOR	559,051		5,453
MATERIAL			
7. Tooling			1,002
8. Lab. Tech.			28
9. Q&RA			15
10. Manufacturing Tech.			1,045
MATERIAL SUBTOTAL (E)			
11. Material & Adm. Burden			355
TOTAL MATERIAL			1,400
TOTAL TOOLING COST			6,853

MLIV
PART IIB
MANUFACTURING
MANUFACTURING TEST
GSE - E/M

ASSEMBLY OR SYSTEM
NON-RECURRING

TABLE 3.2.4.0-V - - - -

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	13,017	126,525
Component Test Planning	4,165	40,484
(1) Subtotal (A)	17,182	167,009
(2) Direct Distributable	5,498	53,441
Subtotal (B)	22,680	220,450
(3) Training	249	2,420
Subtotal (C)	22,929	222,870
(4) Mfg. Tech.	436	5,149
Subtotal (D)	23,365	228,019
(5) Q&RA	4,673	45,422
Total Mfg. Test Labor	28,038	273,441
Material		
(6) Q&RA		1,402
(7) Mfg. Tech.		763
Subtotal (E)		2,165
(8) Material & Adm. Burden		736
Total Material		2,901
Total Mfg. Test Cost		276,342

MLLV
PART II
NON-RECURRING COST
GSF - E/M
ASSEMBLY OR SYSTEM

TABLE 3.2.4.0-VI

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>MATERIAL</u>
Test & C/O Equipment:		
General Equip.	8,247	\$ 31,751
Elec. Test Station	269	1,036
Mech. Test Station	559	2,152
Data Systems Test Station	1,258	4,843
Interconnect Equip.	8,683	33,430
C/O Auc. Equip.	13,398	51,582
Test, C/O, Calif. & Maint. Equip.	286	1,101
Sub Systems Test Equip.	43,258	166,543
Sub Assemblies & Parts Test	48,858	188,103
Data Processing Station	68	262
Engine Test & C/O Equip.	20,722	79,780
Handling & Transportation Equip :		
General Equip.	4,012	15,446
Stage Handling Equip.	94,560	364,056
Component Handling Equip.	12,771	49,168
Stage Transportation Equip.	2,423	9,329
Engine Handling Equip.	972	3,742
TOTAL MGSE	260,344	\$1,002,324

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3.2.5 Manufacturing Facility - Injection Stage Engine Module

Get Ready Costs associated with the Engine Module for additions to the Main Stage manufacturing building, post manufacturing, and stage test building and the office building plus the additional capital equipment are displayed in Table 3.2.5.0-I.

Transportation costs are also included for such items as barges, the tow vehicle, the land transporter, and the cost for the barge trip from the manufacturing facility to the launch site.

For a detailed description of the manufacturing facility refer to Volume III of this report.

TABLE 3.2.5.0-I

MLLV COST SUMMARY

MANUFACTURING FACILITIES - ENGINE MODULE A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						53,395					53,395
TOTAL COST						53,395					53,395

MLLV
RECURRING COST SUMMARY
ANNUAL
MFG. FAC. - ENGINE MODULE
FACILITIES & TRANSPORTATION
(DOLLARS IN THOUSANDS)

TABLE 3.2.5.0-II

<u>Element of Cost</u>	<u>Facilities</u>	<u>Equipment</u>	<u>Transportation</u>
Manufacturing Bldg.	24,625	13,439	
Vertical Assy. Bldg.	3,850	1,381	
Post Mfg. & Stage Test Bldg.	1,200	100	
Office	<u>4,469</u>	<u>529</u>	
Subtotal	34,144	15,449	
<u>Transportation</u>			
Barge			2,333
Tow Vehicle			82
Land Transporter			<u>1,387</u>
Subtotal			3,802
Totals			
Transportation			3,802
Equipment			15,449
Facilities			34,144
(1) Barge Trips			
TOTAL MANUFACTURING FACILITIES ANNUAL RECURRING COST			<u>53,395</u>

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3.2.6 Launch Complex Facility - Injection Stage Engine Module

The share of the Launch Complex Facility for the injection stage - engine module consists of an appropriate allocation of land, buildings, utility systems, machinery, laboratory equipment, electronic equipment, furniture, office equipment, vehicles and other equipment used in launching operations.

The costs of this facility associated with the engine module are displayed in Table 3.2.6.0-I.

TABLE 3.2.6.0-I

MLLV COST SUMMARY LAUNCH COMPLEX FACILITY - ENGINE MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						2,100					2,100
TOTAL COST						2,100					2,100

MLLV
LAUNCH COMPLEX FACILITIES
NON-RECURRING
DOLLARS IN THOUSANDS

TABLE 3.2.6.0-II

BRICK AND MORTAR

1. Site Development Canal, Hyd. Fill, etc.	\$ 46,000	
2. Reenforce Concrete Launch Pad (Flame Deflect)	188,500	
3. Propellant Storage and Transfer and Disposal Systems	79,087	
4. Launch and Test Control Center	23,800	
5. Off-Site Support Complex	31,613	
6. Stage Storage Acceptance Test & Checkout	4,250	
	<hr/>	\$ 373,250

GROUND SUPPORT EQUIPMENT

1. Gentry Equipment	20,349	
2. Unloading Crane	5,891	
3. Service Structure	52,804	
4. Umbilical Tower	12,683	
5. SRM Aft Support Structure	10,317	
6. SRM Fwd. Attach.	6,944	
7. Core Support and Hold Down Boom	14,545	
	<hr/>	\$ 123,533

EQUIPMENT (GENERAL)

1. Test	129,150	
2. Off-Site Support	20,184	
	<hr/>	\$ 149,334

TOTAL LAUNCH FACILITIES

\$ 646,117

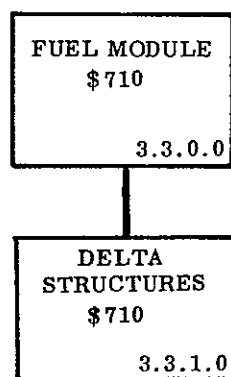
NOTE: Estimated 481,547 - Single Stage
 Estimated 2,100 - Engine Module ←
 Estimated 162,470 - Solid Rocket Motor
646,117

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3.3 INJECTION STAGE - FUEL MODULE

The Get Ready Costs for the injection stage - fuel module are displayed in Figure 3.3.0.0-1. Basically, this cost consists of only the additional cost associated with designing the structure for the fuel module. Engines, systems, GSE, manufacturing and launch facilities costs, shown in 3.2.2 through 3.2.6, are adequate to support the fuel module requirements.



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 3.3.0.0-1 MLLV INJECTION STAGE FUEL MODULE GET READY, "A" COSTS

TABLE 3.3.0.0-I
MLLV COST SUMMARY

FUEL MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	7								7	7
PROGRAM PLAN.& REPT.	2	19								2	19
INDUSTRIAL RELATIONS		3									3
ENGINEERING			45	532						45	532
LAB TECHNICIANS			9	106						9	106
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2	17						2	17
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	3	29	56	655						59	684
MATERIAL				19							19
LOGISTIC HARDWARE											
BURDEN				7							7
TOTAL MATERIAL				26							26
TOTAL OTHER											
TOTAL COST		29		681							710

3.3.1 Structures

TABLE 3.3.1.0-I

MLLV COST SUMMARY

STRUCTURES - FUEL MODULE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	7								1	7
PROGRAM PLAN.& REPT.	2	19								2	19
INDUSTRIAL RELATIONS		3									3
ENGINEERING			45	532						45	532
LAB TECHNICIANS			9	106						9	106
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2	17						2	17
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	3	29	56	655						59	684
MATERIAL				19							19
LOGISTIC HARDWARE											
BURDEN				7							7
TOTAL MATERIAL				26							26
TOTAL OTHER											
TOTAL COST		29		681							710

MLLV
NON-RECURRING
PART I

DESIGN - F/M
ASSEMBLY OR SYSTEM

TABLE 3.3.1.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u> (In Thousands)
<u>Direct Labor</u>			
Engineering	45		
Logistics			
Laboratory Technician	9		
Production			
Tooling			
Manufacturing Test			
Q&RA	2		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>56</u>		
Program Executive		1	7
Program Planning & Reporting		2	19
Industrial Relations			<u>3</u>
Total Labor - Part I		<u>3</u>	<u>29</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			<u>29</u>
TOTAL COST - PART I			

TABLE 3.3.1.0-III

KELV PART II COST SUMMARY

DESIGN - FUEL MODULE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	45	532							45	532
LAB TECHNICIANS	9	106							9	106
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q&RA	2	17							2	17
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	56	655							56	655
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS		18								18
Q&RA		1								1
SUBTOTAL		19								19
MAT. & ADM. BURDEN		7								7
TOTAL MATERIAL		26								26
TOTAL PART II COST		681								681

MLLV		
NON-RECURRING COSTS		
PART II	<u>DESIGN - F/M</u>	
ASSEMBLY OR SYSTEM		
DESIGN ENGINEERING		
TABLE 3.3.1.0-IV		
<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	45,000	531,450
1. Laboratory Technicians	<u>9,000</u>	<u>106,290</u>
Subtotal	54,000	637,740
2. Q&RA	<u>1,800</u>	<u>17,496</u>
TOTAL ENGINEERING LABOR	<u>55,800</u>	<u>655,236</u>
MATERIAL		
3. Laboratory Technicians		18,900
4. Q&RA		<u>540</u>
Subtotal		19,440
5. Material and Adm. Burden		<u>6,610</u>
TOTAL MATERIAL		<u>26,050</u>
TOTAL ENGINEERING COST		<u>681,286</u>

3.4 SRM STAGE FIXED COST

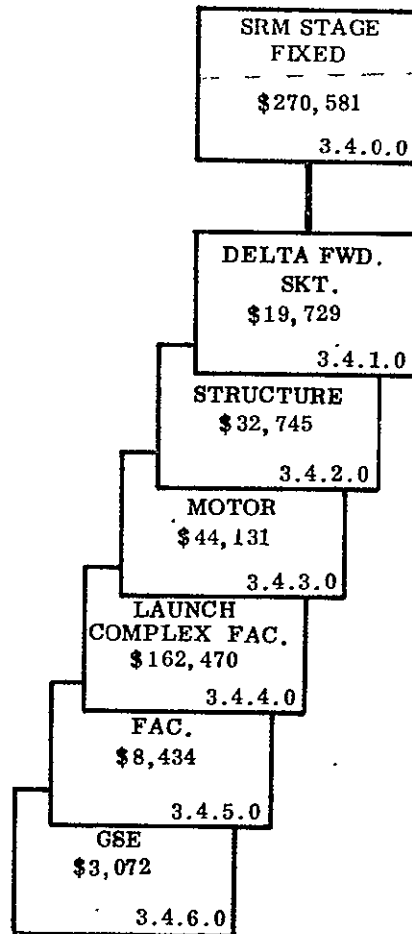
The Get Ready Costs associated with the SRM's were classified into two categories, i.e.: (1) SRM fixed costs, and (2) SRM quantity sensitive costs. This was necessary in order to compensate for the various combinations of SRM's that can be used within the baseline AMLLV vehicle family i.e., 2 to 8 SRM's per vehicle.

The Get Ready Costs in this paragraph are for those items which are not considered quantity sensitive to the number of SRM's per vehicle, i.e.:

- a. The delta cost associated with designing the alternate (heavy weight) forward skirt.
- b. The design of the other structures.
- c. The design of the SRM motor.
- d. The Launch Complex Facility.

The costs shown for the GSE and production facility are based on providing for a production rate of 4 SRM's per year.

The total "FIXED" Get Ready Costs are shown in Figure 3.4.0.0-1.



NOTES:

DOLLARS ARE IN THOUSANDS.

NUMBERS IN LOWER RIGHT CORNER

DESIGNATE APPLICABLE SECTION

NUMBER FOR COST DETAILS.

FIGURE 3.4.0.0-1 MLLV SRM STAGE FIXED COST GET READY, "A" COSTS

TABLE 3.4.0.0-I

MLLV COST SUMMARY TOTAL SRM STAGE (FIXED)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	55	651								55	651
PROGRAM PLAN.& REPT.	138	1,629								138	1,629
INDUSTRIAL RELATIONS	31	298								31	298
ENGINEERING			1,005	11,875						1,005	11,875
LAB TECHNICIANS			159	1,542						159	1,542
TOOLING			2,271	22,070						2,271	22,070
PRODUCTION											
MANUFACTURING TEST			38	368						38	368
MANUFACTURING TECH.			55	654						55	654
Q & R A			591	5,744						591	5,744
FACILITIES											
DIRECT DIST			580	5,636						580	5,636
TRAINING			33	308						33	308
TOTAL DIRECT LABOR	224	2,578	4,732	48,197						4,956	50,775
MATERIAL		6		44,660							44,666
LOGISTIC HARDWARE											
BURDEN				1,164							1,164
TOTAL MATERIAL		6		45,824							45,830
TOTAL OTHER					170,904				*3,072		173,976
TOTAL COST		2,584		94,021	170,904				3,072		270,581

* GSE

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3.4.1 Delta Costs for the Alternate (Heavy Weight) Forward Skirt

The Get Ready Costs shown in this section are those associated with designing the heavy weight forward skirt. This cost is a delta which is over and above the cost of the standard (lightweight) forward skirt.

TABLE 3.4.1.0-I

MLLV COST SUMMARY DELTA FORWARD SHIRT

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	18	209								18	209
PROGRAM PLAN.& REPT.	44	523								44	523
INDUSTRIAL RELATIONS	10	93								10	93
ENGINEERING			336	3,972						336	3,972
LAB TECHNICIANS			67	654						67	654
TOOLING			799	7,763						799	7,763
PRODUCTION											
MANUFACTURING TEST			38	368						38	368
MANUFACTURING TECH.			20	237						20	237
Q & R A			217	2,106						217	2,106
FACILITIES											
DIRECT DIST			212	2,059						212	2,059
TRAINING			12	112						12	112
TOTAL DIRECT LABOR	72	825	1,701	17,271						1,773	18,096
MATERIAL		3		1,218							1,221
LOGISTIC HARDWARE											
BURDEN				412							421
TOTAL MATERIAL		3		1,630							1,633
TOTAL OTHER											
TOTAL COST		828		18,901							19,729

MLLV

PART I

DELTA FWD. SKIRT

ASSEMBLY OR SYSTEM

(IN THOUSANDS)

TABLE 3.4.1.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	336		
Logistics	-		
Laboratory Technician	67		
Production	-		
Tooling	799		
Manufacturing Test	38		
Q&RA	216		
Facilities	-		
Manufacturing Technician	20		
Total Direct Labor	<u>1,476</u>		
Program Executive		18	209
Program Planning & Reporting		444	523
Industrial Relations		<u>10</u>	<u>93</u>
Total Labor - Part I		<u>72</u>	<u>825</u>
<u>Material</u>			
Program Planning & Reporting			2
Industrial Relations			<u>1</u>
Material Subtotal			3
Material & Administrative Burden			<u>0</u>
Total Material			<u>3</u>
TOTAL COST - PART I			<u>828</u>

TABLE 3.4.1.0-III

MLLV PART II COST SUMMARY DELTA FORWARD SKIRT

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	120	1,417			216	2,555			336	3,972
LAB TECHNICIANS	24	233			43	421			67	654
TOOLING					799	7,763			799	7,763
PRODUCTION										
MANUFACTURING TEST							38	368	38	368
MANUFACTURING TECH.					19	226	1	11	20	237
Q & RA	5	46			202	1,962	10	98	217	2,106
DIRECT DIST					200	1,941	12	118	212	2,059
TRAINING						107		5		109
TOTAL DIRECT LABOR	149	1,696			1,490	14,975	62	600	1,701	17,271
MATERIAL										
LAB. TECHNICIANS		51				59				110
TOOLING						1,007				1,007
PRODUCTION										
MFG. TECHNICIANS						34		2		36
Q&RA		2				60		33		65
SUBTOTAL		53				1,160		5		1,218
MAT. & ADM. BURDEN		17				394		1		412
TOTAL MATERIAL		70				1,554		6		1,630
TOTAL PART II COST		1,766				16,529		606		18,901

AMLLV
NON-RECURRING COSTS
PART II-A DELTA FOWARD SKIRT

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

TABLE 3.4.1.0-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	<u>120,000</u>	<u>1,416,950</u>
1. Laboratory Technicians	<u>24,000</u>	<u>232,880</u>
Subtotal	<u>144,000</u>	<u>1,649,830</u>
2. Q&RA	<u>4,800</u>	<u>46,176</u>
TOTAL ENGINEERING LABOR	<u>148,800</u>	<u>1,696,006</u>
 MATERIAL		
3. Laboratory Technicians		<u>50,900</u>
4. Q&RA		<u>1,740</u>
Subtotal		<u>52,640</u>
5. Material and Adm. Burden		<u>17,580</u>
TOTAL MATERIAL		<u>70,220</u>
TOTAL ENGINEERING COST		<u>1,766,226</u>

MLLV
NON-RECURRING COSTS

DELTA FORWARD SKIRT
PART II ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.4.1.0-V

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		216,354	2,555,140
1. Lab. Tech.		<u>43,271</u>	<u>420,592</u>
TOTAL ENGR.		<u>259,625</u>	<u>2,975,732</u>
Fabrication and Erection			
Fab. & Assembly	572,973		5,569,297
Misc. Charges	44,692		434,405
Maintain & Add			
In Scope Changes	<u>6,303</u>		<u>61,262</u>
SUBTOTAL	<u>623,968</u>		<u>6,064,964</u>
2. Tool and Production Planning	<u>174,711</u>		<u>1,698,191</u>
SUBTOTAL	798,679		7,763,155
3. Direct Distributable	<u>199,669</u>		<u>1,940,789</u>
SUBTOTAL	<u>998,348</u>		<u>9,703,944</u>
4. Training	<u>10,982</u>		<u>106,744</u>
SUBTOTAL	<u>949,330</u>		<u>9,810,688</u>
5. Q&RA	<u>201,866</u>		<u>1,962,138</u>
6. Manufacturing Tech.	<u>19,177</u>		<u>226,483</u>
TOTAL PRODUCTION LABOR	<u>1,230,373</u>		<u>11,999,309</u>
MATERIAL			
7. Tooling			<u>1,006,534</u>
8. Lab. Tech.			<u>58,954</u>
9. Q&RA			<u>60,560</u>
10. Manufacturing Tech.			<u>33,560</u>
MATERIAL SUBTOTAL			<u>1,159,608</u>
11. Material & Adm. Burden			<u>394,267</u>
TOTAL MATERIAL			<u>1,553,875</u>
TOTAL TOOLING COST			<u>16,528,916</u>

MLLV
PART IIB
MANUFACTURING
MANUFACTURING TEST
DELTA FORWARD SKIRT
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 3.4.1.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	28,649	278,469
Component Test Planning	<u>9,168</u>	<u>89,109</u>
(1) Subtotal (A)	37,817	367,578
(2) Direct Distributable	<u>12,101</u>	<u>117,625</u>
Subtotal (B)	44,918	485,203
(3) Training	<u>549</u>	<u>5,337</u>
Subtotal (C)	45,467	485,203
(4) Mfg. Tech.	<u>959</u>	<u>11,325</u>
Subtotal (D)	51,426	501,865
(5) Q&RA	<u>10,094</u>	<u>98,108</u>
Total Mfg. Test Labor	<u>61,520</u>	<u>599,973</u>
Material		
(6) Q&RA		3,028
(7) Mfg. Tech.		<u>1,678</u>
Subtotal (E)		4,706
(8) Material & Adm. Burden		<u>1,600</u>
Total Material		<u>6,306</u>
Total Mfg. Test Cost		<u>606,279</u>

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3.4.2 Stage Structures for SRM

The Get Ready Costs shown in Table 3.4.2.0-I are for the design, fabrication and assembly, and tool setup for other structures such as: Aft skirt fittings, nose cone and forward skirt of the SRM.

TABLE 3.4.2.0-I

MLLV COST SUMMARY

TOTAL SRM STRUCTURE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	29	344								29	344
PROGRAM PLAN. & REPT.	73	861								73	861
INDUSTRIAL RELATIONS	16	153								16	153
ENGINEERING			457	5,394						457	5,394
LAB TECHNICIANS			92	888						92	888
TOOLING			1,472	14,307						1,472	14,307
PRODUCTION											
MANUFACTURING TEST											44
MANUFACTURING TECH.			35	417						35	762
Q & R A			374	3,638						374	3,249
FACILITIES											
DIRECT DIST			368	3,577						368	3,577
TRAINING			21	196						21	196
TOTAL DIRECT LABOR	118	1,358	2,819	28,417						2,937	29,775
MATERIAL		3		2,215							2,218
LOGISTIC HARDWARE											
BURDEN				752							752
TOTAL MATERIAL		3		2,967							2,970
TOTAL OTHER											
TOTAL COST		1,361		31,384							32,745

TABLE 3.4.2.0-II

MLLV COST SUMMARY SRM NOSE CONE

"A"

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	8	98								8	98
PROGRAM PLAN.& REPT.	21	245								21	245
INDUSTRIAL RELATIONS	5	43								5	43
ENGINEERING			127	1,508						127	1,508
LAB TECHNICIANS			26	248						26	248
TOOLING			422	4,103						422	4,103
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.			10	120						10	120
Q & R A			108	1,042						108	1,042
FACILITIES											
DIRECT DIST.			106	1,026						106	1,026
TRAINING			6	56						6	56
TOTAL DIRECT LABOR	34	386	805	8,103						839	8,429
MATERIAL		1		634							635
LOGISTIC HARDWARE											
BURDEN				215							215
TOTAL MATERIAL		1		849							850
TOTAL OTHER											
TOTAL COST		387		8,952							9,339

MLLV
NON-RECURRING
PART I
SRM NOSE CONE
ASSEMBLY OR SYSTEM

TABLE 3.4.2.0-III

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	127,686		
Logistics			
Laboratory Technician	25,537		
Production			
Tooling	422,109		
Manufacturing Test			
Q&RA	107,222		
Facilities			
Manufacturing Technician	<u>10,135</u>		
Total Direct Labor	<u>692,689</u>		
Program Executive		8,312	98,165
Program Planning & Reporting		20,781	245,424
Industrial Relations		<u>4,437</u>	<u>43,128</u>
Total Labor - Part I		<u></u>	<u>386,717</u>
<u>Material</u>			
Program Planning & Reporting			416
Industrial Relations			<u>444</u>
Material Subtotal			860
Material & Administrative Burden			<u>292</u>
Total Material			<u>1,152</u>
TOTAL COST - PART I			<u>387,869</u>

TABLE 3.4.2.0-IV

MLIV PART II COST SUMMARY

SRM NOSE CONE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	13	157			114	1,351			127	1,508
LAB TECHNICIANS	3	26			23	222			26	248
TOOLING					422	4,103			422	4,103
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.					10	120			10	120
Q & RA	1	5			107	1,037			108	1,042
DIRECT DIST					106	1,026			106	1,026
TRAINING					6	56			6	56
TOTAL DIRECT LABOR	17	188			788	7,915			805	8,103
MATERIAL										
LAB. TECHNICIANS		6				48				54
TOOLING						530				530
PRODUCTION										
MFG. TECHNICIANS						18				18
Q&RA						32				32
SUBTOTAL		6				628				634
MAT. & ADM. BURDEN		2				213				215
TOTAL MATERIAL		8				841				849
TOTAL PART II COST		196				8,756				8,952

MLLV			
NON-RECURRING COSTS			
PART II-A SRM NOSE CONE			
ASSEMBLY OR SYSTEM			
DESIGN ENGINEERING			
TABLE 3.4.2.0-V			
<u>ELEMENT OF COST</u>		<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		13,340	157,545
1. Laboratory Technicians		<u>2,668</u>	<u>25,933</u>
Subtotal		16,008	183,478
2. Q&RA		<u>534</u>	<u>5,190</u>
TOTAL ENGINEERING LABOR		<u>16,542</u>	<u>188,668</u>
MATERIAL			
3. Laboratory Technicians			5,603
4. Q&RA			<u>160</u>
Subtotal			<u>5,763</u>
5. Material and Adm. Burden			<u>1,959</u>
TOTAL MATERIAL			<u>7,722</u>
TOTAL ENGINEERING COST			<u>196,390</u>

MLLV
NON-RECURRING COSTS
SRM
NOSE CONE
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.4.2.0-VI

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		114,346	1,350,426
1. Lab. Tech.		<u>22,869</u>	<u>222,287</u>
TOTAL ENGR.		<u>137,215</u>	<u>1,575,713</u>
Fabrication and Erection			
Fab. & Assembly	302,822		2,943,430
Misc. Charges	23,620		229,586
Maintain & Add			
In Scope Changes	<u>3,331</u>		<u>32,377</u>
SUBTOTAL (A)	<u>329,773</u>		<u>3,205,393</u>
2. Tool and Production Planning	<u>92,336</u>		<u>897,506</u>
SUBTOTAL (B)	<u>422,109</u>		<u>4,102,897</u>
3. Direct Distributable	<u>105,527</u>		<u>1,025,722</u>
SUBTOTAL (C)	<u>527,636</u>		<u>5,128,621</u>
4. Training	<u>5,804</u>		<u>56,415</u>
SUBTOTAL (D)	<u>533,440</u>		<u>5,185,036</u>
5. Q&RA	<u>106,688</u>		<u>1,037,007</u>
6. Manufacturing Tech.	<u>10,135</u>		<u>119,694</u>
TOTAL PRODUCTION LABOR	<u>650,263</u>		<u>6,341,737</u>
MATERIAL			
7. Tooling			<u>529,939</u>
8. Lab. Tech.			<u>48,025</u>
9. Q&RA			<u>32,006</u>
10. Manufacturing Tech.			<u>17,736</u>
MATERIAL SUBTOTAL (E)			<u>627,706</u>
11. Material & Adm. Burden			<u>213,420</u>
TOTAL MATERIAL			<u>841,126</u>
TOTAL TOOLING COST			<u>8,755,576</u>

TABLE 3.4.2.0-VII

MLLV COST SUMMARY

SRM ATTACH STRUCTURE

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	17	196								17	196
PROGRAM PLAN.& REPT.	41	491								41	491
INDUSTRIAL RELATIONS	9	88								9	88
ENGINEERING			259	3,053						259	3,053
LAB TECHNICIANS			52	503						52	503
TOOLING			841	8,173						841	8,173
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.			20	238						20	238
Q & R A			213	2,078						213	2,078
FACILITIES											
DIRECT DIST			210	2,043						210	2,043
TRAINING			12	112						12	112
TOTAL DIRECT LABOR	67	775	1,607	16,200						1,674	16,975
MATERIAL		2		1,264							1,266
LOGISTIC HARDWARE											
BURDEN				430							430
TOTAL MATERIAL		2		1,694							1,696
TOTAL OTHER											
TOTAL COST		777		17,894							18,671

MLLV
NON-RECURRING

PART I
SRM ATTACH STRUCTURE
ASSEMBLY OR SYSTEM
TABLE 3.4.2.0-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	258,508		
Logistics			
Laboratory Technician	51,702		
Production			
Tooling	840,813		
Manufacturing Test			
Q&RA	213,745		
Facilities			
Manufacturing Technician	20,189		
Total Direct Labor	1,384,957		
Program Executive		16,619	196,270
Program Planning & Reporting		41,549	490,694
Industrial Relations		9,002	87,499
Total Labor - Part I		67,170	774,463
<u>Material</u>			
Program Planning & Reporting			831
Industrial Relations			900
Material Subtotal			1,731
Material & Administrative Burden			589
Total Material			2,320
TOTAL COST - PART I			776,783

TABLE 3.4.2.0-IX

PART II COST SUMMARY SRM ATTACH STRUCTURE

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	31	363			228	2,690			259	3,053
LAB TECHNICIANS	6	60			46	443			52	503
TOOLING					841	8,173			841	8,173
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.					20	238			20	238
Q & RA	1	12			212	2,066			213	2,078
DIRECT DIST					210	2,043			210	2,043
TRAINING					12	112			12	112
TOTAL DIRECT LABOR	38	435			1,569	15,765			1,607	16,200
MATERIAL										
LAB. TECHNICIANS		13				96				109
TOOLING						1,056				1,056
PRODUCTION										
MFG. TECHNICIANS						35				35
Q&RA						64				64
SUBTOTAL		13				1,251				1,264
MAT. & ADM. BURDEN		5				425				430
TOTAL MATERIAL		18				1,676				1,694
TOTAL PART II COST		453				17,441				17,894

MLLV
NON-RECURRING COSTS
PART II-A SRM ATTACH STRUCTURE

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	TABLE 3.4.2.0-X	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		30,740	363,039
1. Laboratory Technicians		<u>6,148</u>	<u>59,759</u>
Subtotal		36,888	422,798
2. Q&RA		<u>1,230</u>	<u>11,956</u>
TOTAL ENGINEERING LABOR		<u>38,118</u>	<u>434,754</u>
MATERIAL			
3. Laboratory Technicians			12,911
4. Q&RA			<u>369</u>
Subtotal			13,280
5. Material and Adm. Burden			<u>4,515</u>
TOTAL MATERIAL			<u>17,795</u>
TOTAL ENGINEERING COST			<u>452,549</u>

MLLV
NON-RECURRING COSTS
SRM ATTACH STRUCTURE
PART IIB ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.4.2.0-XI

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		227,768	2,689,940
1. Lab. Tech.		<u>45,554</u>	<u>442,785</u>
TOTAL ENGR.		<u>273,322</u>	<u>3,132,725</u>
Fabrication and Erection			
Fab. & Assembly	603,200		5,863,104
Misc. Charges	47,050		457,326
Maintain & Add In Scope Changes	<u>6,635</u>		<u>64,492</u>
SUBTOTAL (A)	656,885		6,384,922
2. Tool and Production Planning	<u>683,928</u>		<u>1,787,780</u>
SUBTOTAL (B)	840,813		8,172,702
3. Direct Distributable	<u>210,203</u>		<u>2,043,173</u>
SUBTOTAL (C)	1,051,016		10,215,875
4. Training	<u>11,561</u>		<u>112,373</u>
SUBTOTAL (D)	1,062,577		10,328,248
5. Q&RA	212,515		2,065,646
6. Manufacturing Tech.	<u>20,189</u>		<u>238,432</u>
TOTAL PRODUCTION LABOR	<u>1,295,281</u>		<u>12,632,326</u>
MATERIAL			
7. Tooling			1,055,600
8. Lab. Tech.			95,663
9. Q&RA			63,755
10. Manufacturing Tech.			35,331
MATERIAL SUBTOTAL (E)			<u>1,250,349</u>
11. Material & Adm. Burden			<u>425,119</u>
TOTAL MATERIAL			<u>1,675,468</u>
TOTAL TOOLING COST			<u>17,440,519</u>

TABLE 3.4.2.0-XII

MLLV COST SUMMARY SRM AFT SKIRT

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	37								3	37
PROGRAM PLAN.& REPT.	8	93								8	93
INDUSTRIAL RELATIONS	2	17								2	17
ENGINEERING			52	605						52	605
LAB TECHNICIANS			10	100						10	100
TOOLING			157	1,527						157	1,527
PRODUCTION											
MANUFACTURING TEST			4	44						4	44
MANUFACTURING TECH.			40	389						40	389
Q & R A											
FACILITIES											
DIRECT DIST.			39	382						39	382
TRAINING			2	21						2	21
TOTAL DIRECT LABOR	13	147	304	3,068						317	3,215
MATERIAL				238							238
LOGISTIC HARDWARE											
BURDEN				80							80
TOTAL MATERIAL				318							318
TOTAL OTHER											
TOTAL COST		147		3,386							3,533

MLLV
NON-RECURRING
SRM-AFT SKIRT
PART I

ASSEMBLY OR SYSTEM
TABLE 3.4.2.0-XIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	51,247		
Logistics			
Laboratory Technician	10,249		
Production			
Tooling	157,061		
Manufacturing Test			
Q&RA	40,045		
Facilities			
Manufacturing Technician	<u>3,771</u>		
Total Direct Labor	<u>262,373</u>		
Program Executive		3,148	37,178
Program Planning & Reporting		7,871	92,957
Industrial Relations		<u>1,705</u>	<u>16,573</u>
Total Labor - Part I		<u>12,724</u>	<u>146,708</u>
<u>Material</u>			
Program Planning & Reporting			157
Industrial Relations			171
Material Subtotal			<u>328</u>
Material & Administrative Burden			<u>112</u>
Total Material			<u>440</u>
TOTAL COST - PART I			<u>147,148</u>

TABLE 3.4.2.0-XIV

MLV PART II COST SUMMARY

SRM - AFT SKIRT

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	9	103			43	502			52	605
LAB TECHNICIANS	2	17			8	83			10	100
TOOLING					157	1,527			157	1,527
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.					4	44			4	44
Q&RA		3			40	386			40	389
DIRECT DIST					39	382			39	382
TRAINING					2	21			2	21
TOTAL DIRECT LABOR	11	123			293	2,945			304	3,068
MATERIAL		4				18				22
LAB. TECHNICIANS						197				197
TOOLING										
PRODUCTION										
MFG. TECHNICIANS						7				7
Q&RA						12				12
SUBTOTAL		4				234				238
MAT. & ADM. BURDEN		1				79				80
TOTAL MATERIAL		5				313				318
TOTAL PART II COST		128				3,258				3,386

MLLV		
NON-RECURRING COSTS		
PART II-A SRM - AFT SKIRT		
ASSEMBLY OR SYSTEM		
DESIGN ENGINEERING		
TABLE 3.4.2.0-XV		
<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	8,700	102,747
1. Laboratory Technicians	<u>1,740</u>	<u>16,913</u>
Subtotal	10,440	119,660
2. Q&RA	<u>348</u>	<u>3,383</u>
TOTAL ENGINEERING LABOR	<u>10,788</u>	<u>123,043</u>
MATERIAL		
3. Laboratory Technicians		3,654
4. Q&RA		<u>104</u>
Subtotal		3,758
5. Material and Adm. Burden		<u>1,278</u>
TOTAL MATERIAL		<u>5,036</u>
TOTAL ENGINEERING COST		<u>128,079</u>

MLLV NON-RECURRING COSTS SRM - AFT SKIRT PART IIB ASSEMBLY OR SYSTEM TOOLING TABLE 3.4.2.0-XVI			COLUMN I MANHOURS	COLUMN II MANHOURS	COLUMN III DOLLARS
ELEMENT OF COST					
TOOL DESIGN				42,547	502,480
1. Lab. Tech.				8,509	82,707
TOTAL ENGR.				51,056	585,187
Fabrication and Erection					
Fab. & Assembly			112,676		1,095,211
Misc. Charges			8,789		85,429
Maintain & Add					
In Scope Changes			1,239		12,043
SUBTOTAL (A)			122,704		1,192,683
2. Tool and Production Planning			34,357		333,950
SUBTOTAL (B)			157,061		1,526,633
3. Direct Distributable			39,265		381,656
SUBTOTAL (C)			196,326		1,908,289
4. Training			2,160		20,995
SUBTOTAL (D)			198,486		1,929,284
5. Q&RA			39,697		385,855
6. Manufacturing Tech.			3,771		44,536
TOTAL PRODUCTION LABOR			241,954		2,359,675
MATERIAL					
7. Tooling					197,183
8. Lab. Tech.					17,869
9. Q&RA					11,909
10. Manufacturing Tech.					6,599
MATERIAL SUBTOTAL (E)					233,560
11. Material & Adm. Burden					79,410
TOTAL MATERIAL					312,970
TOTAL TOOLING COST					3,257,832

TABLE 3.4.2.0-XVII

MLLV COST SUMMARY

SRM FITTINGS

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	13								1	13
PROGRAM PLAN.& REPT.	3	32								3	32
INDUSTRIAL RELATIONS		5									5
ENGINEERING			19	228						19	228
LAB TECHNICIANS			4	37						4	37
TOOLING			52	504						52	504
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.			1	15						1	15
Q & R A			13	129						13	129
FACILITIES											
DIRECT DIST			13	126						13	126
TRAINING			1	7						1	7
TOTAL DIRECT LABOR	4	50	103	1,046						107	1,096
MATERIAL				79							79
LOGISTIC HARDWARE											
BURDEN				27							27
TOTAL MATERIAL				106							106
TOTAL OTHER											
TOTAL COST		50		1,152							1,202

MLLV
NON-RECURRING
SRM FITTINGS
PART I
SRM FITTINGS
ASSEMBLY OR SYSTEM
TABLE 3.4.2.0-XVIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	19,256		
Logistics			
Laboratory Technician	3,851		
Production			
Tooling	51,816		
Manufacturing Test			
Q&RA	13,305		
Facilities			
Manufacturing Technician	<u>1,244</u>		
Total Direct Labor	<u>89,472</u>		
Program Executive		1,074	12,684
Program Planning & Reporting		2,684	31,698
Industrial Relations		<u>582</u>	<u>5,657</u>
Total Labor - Part I		<u>4,340</u>	<u>50,039</u>
<u>Material</u>			
Program Planning & Reporting			54
Industrial Relations			58
Material Subtotal			<u>112</u>
Material & Administrative Burden			<u>38</u>
Total Material			<u>150</u>
TOTAL COST - PART I			<u>50,189</u>

TABLE 3.4.2.0-XIX

MILV PART II COST SUMMARY

SRM - FITTINGS

A ☒ B ☐ C ☐ (IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	5	62			14	166			19	228
LAB TECHNICIANS	1	10			3	27			4	37
TOOLING					52	504			52	504
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.					1	15			1	15
Q & RA		2			13	127			13	129
DIRECT DIST					13	126			13	126
TRAINING					1	7			1	7
TOTAL DIRECT LABOR	6	74			97	972			103	1,046
MATERIAL										
LAB. TECHNICIANS		2				6				8
TOOLING						65				65
PRODUCTION										
MFG. TECHNICIANS						2				2
Q&RA						4				4
SUBTOTAL		2				77				79
MAT. & ADM. BURDEN		1				26				27
TOTAL MATERIAL		3				103				106
TOTAL PART II COST		77				1,075				1,152

MLLV			
NON-RECURRING COSTS			
PART II-A <u>FITTINGS</u>			
ASSEMBLY OR SYSTEM			
DESIGN ENGINEERING			
TABLE 3.4.2.0-XX			
<u>ELEMENT OF COST</u>		<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		5,220	61,648
1. Laboratory Technicians		<u>1,044</u>	<u>10,148</u>
Subtotal		6,264	71,796
2. Q&RA		<u>209</u>	<u>2,031</u>
TOTAL ENGINEERING LABOR		<u>6,473</u>	<u>73,827</u>
MATERIAL			
3. Laboratory Technicians			2,195
4. Q&RA			<u>63</u>
Subtotal			2,195
5. Material and Adm. Burden			<u>767</u>
TOTAL MATERIAL			<u>3,022</u>
TOTAL ENGINEERING COST			<u>76,849</u>

MLLV
NON-RECURRING COSTS

SRM FITTINGS
PART IIB ASSEMBLY OR SYSTEM
TOOLING
TABLE 3.4.2.0-XXI

<u>ELEMENT OF COST</u>	<u>COLUMN I MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		14,036	165,765
1. Lab. Tech.		<u>2,807</u>	<u>27,284</u>
TOTAL ENGR.		<u>16,843</u>	<u>193,049</u>
Fabrication and Erection			
Fab. & Assembly	37,173		361,322
Misc. Charges	2,899		28,178
Maintain & Add In Scope Changes	<u>409</u>		<u>3,975</u>
SUBTOTAL (A)	40,481		393,475
2. Tool and Production Planning	<u>11,335</u>		<u>110,176</u>
SUBTOTAL (B)	51,816		503,651
3. Direct Distributable	<u>12,954</u>		<u>125,913</u>
SUBTOTAL (C)	64,770		629,564
4. Training	<u>712</u>		<u>6,921</u>
SUBTOTAL (D)	65,482		636,485
5. Q&RA	13,096		127,293
6. Manufacturing Tech.	<u>1,244</u>		<u>14,692</u>
TOTAL PRODUCTION LABOR	<u>79,822</u>		<u>778,470</u>
MATERIAL			
7. Tooling			65,053
8. Lab. Tech.			5,895
9. Q&RA			3,929
10. Manufacturing Tech.			<u>2,177</u>
MATERIAL SUBTOTAL (E)			77,054
11. Material & Adm. Burden			26,198
TOTAL MATERIAL			<u>103,252</u>
TOTAL TOOLING COST			<u>1,074,771</u>

3.4.3 The SRM Motor

The Get Ready Costs shown in this section are those costs directly related to the Engineering design of the SRM motor and tooling design. Also, the Get Ready Cost of the actual tooling is included. This tooling includes:

Development Tooling

- Process tooling
- Tooling maintenance and modification
- Chamber tooling
- Nozzle shell tooling
- Ablative and exit cone tooling
- Auxiliary power unit tooling
- Igniter tooling
- Inspection tooling

Production Tooling

- Process tooling
- Chamber tooling
- Nozzle shell tooling
- Ablatives and exit cone tooling
- Inspection tooling

The total costs for this item are displayed in Table 3.4.3.0-I.

TABLE 3.4.3.0-I
MLLV COST SUMMARY

SOLID ROCKET MOTOR

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	8	98								8	98
PROGRAM PLAN.& REPT.	21	245								21	245
INDUSTRIAL RELATIONS	5	52								5	52
ENGINEERING			212	2,509						212	2,509
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	34	395	212	2,509						246	2,904
MATERIAL				41,227							41,227
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				41,227							41,227
TOTAL OTHER											
TOTAL COST		395		43,736							44,131

MLLV
NON-RECURRING

PART I

ASSEMBLY OR SYSTEM

TABLE 3.4.3.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production			
Tooling			
Manufacturing Test			
Q&RA			
Facilities			
Manufacturing Technician			
Total Direct Labor			
Program Executive		8,295	97,960
Program Planning & Reporting		20,737	244,900
Industrial Relations		<u>5,364</u>	<u>52,140</u>
Total Labor - Part I		<u>34,396</u>	<u>395,000</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>395,000</u>

MLLV PART II COST SUMMARY

ASSEMBLY OR SYSTEM
"A" COSTS

(IN THOUSANDS)

ELEMENT OF COST	DESIGN ENGINEERING		PRODUCTION		DESIGN & FAB. TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
Engineering	152	1,795			60	714			212	2,509
Lab Technicians										
Tooling										
Production										
Manufacturing Test										
Manufacturing Tech.										
Quality & Reliability Assurance										
Direct Distributable Training										
Total Direct Labor	152	1,795			60	714			212	2,509
Material										
Lab. Technicians										
Tooling						41,227				41,227
Production										
Mfg. Technicians										
Quality & Reliability Assurance										
Subtotal						41,227				41,227
Material & Administrative Burden										
Total Material						41,227				41,227
TOTAL PART II COST		1,795				41,941				43,736

AMLLV
NON-RECURRING COSTS

SOLID ROCKET MOTOR
PART II ASSEMBLY OR SYSTEM
TOOLING

TABLE 3.4.3.0-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>COLUMN II MANHOURS</u>	<u>COLUMN III DOLLARS</u>
TOOL DESIGN		60,457	714,000
1. Lab. Tech.			
TOTAL ENGR.		<u>60,457</u>	<u>714,000</u>
Fabrication and Erection			
Fab. & Assembly			
Misc. Charges			
Maintain & Add			
In Scope Changes			
SUBTOTAL			
2. Tool and Production Planning			
SUBTOTAL			
3. Direct Distributable			
SUBTOTAL			
4. Training			
SUBTOTAL			
5. Q&RA			
6. Manufacturing Tech.			
TOTAL PRODUCTION LABOR			
MATERIAL			
7. Tooling *			41,227,000
8. Lab. Tech.			
9. Q&RA			
10. Manufacturing Tech.			
MATERIAL SUBTOTAL			
11. Material & Adm. Burden			41,227,000
TOTAL MATERIAL			<u>41,227,000</u>
TOTAL TOOLING COST			<u>41,941,000</u>

*Includes both manhours and material. No further breakout was given by Aerojet.

AMLLV
NON-RECURRING COSTS
PART II-A SOLID ROCKET MOTOR

ASSEMBLY OR SYSTEM
DESIGN ENGINEERING
TABLE 3.4.3.0-V

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN	151,990	1,795,000
1. Laboratory Technicians	_____	_____
Subtotal		
2. Q&RA	_____	_____
TOTAL ENGINEERING LABOR	<u>151,990</u>	<u>1,795,000</u>
MATERIAL		
3. Laboratory Technicians		
4. Q&RA		
Subtotal		
5. Material and Adm. Burden		_____
TOTAL MATERIAL		=====
TOTAL ENGINEERING COST		<u>1,795,000</u>

MLLV
SOLID ROCKET MOTOR
NON-RECURRING
DOLLARS IN THOUSANDS

TABLE 3.4.3.0-VI

1.	Management and Administration		\$ 395
2.	Engineering		1,795
3.	Tooling and Design Labor		714
4.	Tooling:		
	<u>Development</u>		
	Process Tooling	\$ 4,622	
	Tooling Maintenance and Modification	1,715	
	Chamber Tooling	3,887	
	Nozzel Shell Tooling	720	
	Ablatives and Exit Cone Tooling	906	
	Auxiliary Power Unit Tooling	239	
	Igniter Tooling	116	
	Inspection Tooling	<u>1,071</u>	13,276
	<u>Production</u>		
	Process Tooling	14,100	
	Chamber Tooling	10,383	
	Nozzel Shell Tooling	1,605	
	Ablatives and Exit Cone Tooling	1,531	
	Inspection Tooling	<u>352</u>	27,951
	TOTAL COST		<u><u>\$44,131</u></u>

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3.4.4 Launch Complex Facility - SRM Stage

The Get Ready Cost for that portion of the Launch Complex Facility associated with SRM stages are:

- Site development canal, hydraulic, fill, etc.
- Gantry crane
- Unloading hoist
- SRM rotating fixture
- Service structure
- Umbilical tower
- SRM aft support structure
- SRM forward attachment and alignment boom mechanism
- Launch and test control center
- Off site support complex

This cost is based on the provision of a facility capable of a launch rate of two vehicles per year with each vehicle consisting of a main stage and eight SRM strap-on stages. The total cost is displayed in Table 3.4.4.0-I.

TABLE 3.4.4.0-I

MLLV COST SUMMARY SRM LAUNCH COMPLEX FACILITY

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING .											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						162,470					162,470
TOTAL COST						162,470					162,470

MLLV
LAUNCH COMPLEX FACILITIES
NON-RECURRING
DOLLARS IN THOUSANDS

TABLE 3.4.4.0-II

BRICK AND MORTAR

1..	Site Development Canal, Hyd. Fill, etc.	\$ 46,000
2.	Reenforce Concrete Launch Pad (Flame Deflect)	188,500
3.	Propellant Storage and Tansfer and Disposal Systems	79,087
4.	Launch and Test Control Center	23,800
5.	Off-Site Support Complex	31,613
6.	Stage Storage Acceptance Test & Checkout	4,250

\$ 373,250

GROUND SUPPORT EQUIPMENT

1.	Gentry Equipment	20,349
2.	Unloading Crane	5,891
3.	Service Structure	52,804
4.	Umbilical Tower	12,683
5.	SRM Aft Support Structure	10,317
6.	SRM Fwd. Attach.	6,944
7.	Core Support and Hold Down Boom	14,545

\$ 123,533

EQUIPMENT (GENERAL)

1.	Test	129,150
2.	Off-Site Support	20,184

\$ 149,334

TOTAL LAUNCH FACILITIES

\$ 646,117

NOTE: Estimated 481,547 - Single Stage
 Estimated 2,100 - Engine Module
 Estimated 162,470 - Solid Rocket Motor ←
 646,117

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3.4.5 SRM Manufacturing Facility - Fixed Costs

The fixed Get Ready Costs for the SRM manufacturing facility were defined design costs necessary to established the minimum requirements for the production of 260 inch SRM motors regardless of the quantity of SRM's to be built.' Table 3.4.5.0-I displays these costs.

NOTE: Refer to Paragraph 3.5.2 for the additional facility costs associated with the actual production of the SRM's which are quantity sensitive.

TABLE 3.4.5.0-I

MLLV COST SUMMARY SRM STAGE-MANUFACTURING FACILITIES

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						8,434					8,434
TOTAL COST						8,434					8,434

MLLV
NON-RECURRING
MANUFACTURING FACILITIES
SRM
DOLLARS IN THOUSANDS

TABLE 3.4.5.0-II

AEROJET

Production	\$ 45,100
------------	-----------

*OTHER CONTRACTOR

Brick & Mortar	\$ 3,230	
Handling Equipment	434	
Capital Equipment	840	
	5,504	

Total Manufacturing Facilities	\$ 50,604
--------------------------------	-----------

* Facilities required to build attach structure, nose cone, aft skirt, and fittings for SRM at Michoud. These are required in addition to the facilities required for the core stage vehicle.

Estimated:	Fixed cost of	8,434	←
	Variable cost of	42,170	
		50,604	

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3.4.6 Ground Support Equipment (GSE) - SRM Stage

The Get Ready Cost for SRM GSE includes the following items:

- Electronic checkout van
- Hydraulic power servicing unit
- Motor leakage pressurization unit
- Leak detection unit, helium type
- Pneumatic power supply cart
- Nozzle/TVC alignment kit
- Maintenance stands
- Environmental monitoring equipment
- Handling equipment
- Barges (9)

The costs associated with this equipment is displayed in Table 3.4.6.0-I. These costs are fixed in nature and are additive to the Quantity Sensitive Costs reflected in sub-paragraph 3.5.1.

TABLE 3.4.6.0-I

MLLV COST SUMMARY SRM STAGE - GROUND SUPPORT EQUIPMENT

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									3,072		3,072
TOTAL COST									3,072		3,072

MLLV


SRM

*GROUND SUPPORT EQUIPMENT

DOLLARS IN THOUSANDS

TABLE 3.4.6.0-II

1. Electronic Checkout Van	\$ 437
2. Hydraulic Power Servicing Unit	51
3. Motor Backage Pressurization Unit	32
4. Leak Detection Unit, Helium Type	19
5. Pneumatic Power Supply Cart	36
6. Nozzle/TVC Alignment Kit	20
7. Maintenance Stands	123
8. Environmental Monitoring Equipment	14
9. Handling Equipment	30
10. Barges (9)	<u>18,000</u>
TOTAL GSE	<u><u>18,762</u></u>

NOTE: Estimated fixed cost at	3,072	
Estimated variable cost at	<u>15,690</u>	
	<u><u>18,762</u></u>	

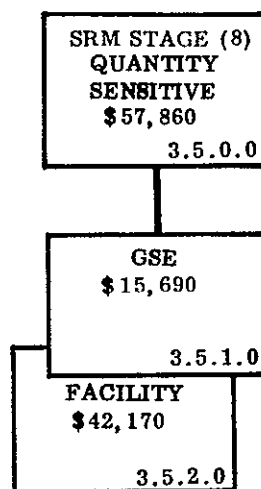
*Based on Aerojet input for Sat V/4-260 Study

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3.5 SRM STAGE QUANTITY SENSITIVE COST

The Get Ready Cost details for the 260 inch SRM's shown in Figure 3.5.0.0-1 are those costs directly related to the actual number of SRM's to be produced. The maximum units per year, for purposes of this study, was assumed to be sixteen per year. The costs in this paragraph are those costs required to increase the SRM production rate from 4 to 16 units per year. They are additive to those costs shown in Sections 3.4.5 and 3.4.6 for the Manufacturing Facility and GSE.



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 3.5.0.0-1 MLLV SOLID MOTOR STAGE QUANTITY SENSITIVE COSTS
GET READY, "A" COSTS

TABLE 3.5.0.0-I

MLLV COST SUMMARY

TOTAL SRM STAGE (VARIABLE)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAE TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & RA											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						42,170			*15,690		57,860
TOTAL COST						42,170			15,690		57,860

* GSE

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3.5.1 Ground Support Equipment (GSE) - SRM Stage

The SRM quantity sensitive GSE requirements are those costs associated with the production of 16 stages per year. These costs are displayed in Table 3.5.1.0-I, and are in addition to those costs reflected in sub-paragraph 3.4.6.

TABLE 3.5.2.0-I

MLLV COST SUMMARY - GROUND SUPPORT EQUIP (VARIABLE)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									15,690		15,690
TOTAL COST									15,690		15,690

MLLV

SRM

*GROUND SUPPORT EQUIPMENT
DOLLARS IN THOUSANDS

TABLE 3.5.2.0-II

1. Electronic Checkout Van	\$ 437
2. Hydraulic Power Servicing Unit	51
3. Motor Backage Pressurization Unit	32
4. Leak Detection Unit, Helium Type	19
5. Pneumatic Power Supply Cart	36
6. Nozzle/TVC Alignment Kit	20
7. Maintenance Stands	123
8. Environmental Monitoring Equipment	14
9. Handling Equipment	30
10. Barges (9)	18,000
	<hr/>
TOTAL GSE	\$ 18,762
	<hr/>

NOTE: Estimated fixed cost at	3,072	
Estimated variable cost at	15,690	←
	<hr/>	
	18,762	
	<hr/>	

*Based on Aerojet input for Sat V/4-260 Study

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3.5.2 SRM Manufacturing Facility

The SRM motor quantity sensitive manufacturing facility costs are those costs associated with the actual number of stages to be produced per year. These costs are reflected in Table 3.5.2.0-I, and are in addition to the fixed facility costs in subparagraph 3.4.5.

TABLE 3.5.1.0-I

MLLV COST SUMMARY

MANUFACTURING FACILITIES (VARIABLE)

A ☒ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAE TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						42,170					42,170
TOTAL COST						42,170					42,170

MLLV
NON-RECURRING
MANUFACTURING FACILITIES
SRM
DOLLARS IN THOUSANDS
TABLE 3.5.1.0-II

AEROJET

Production	\$ <u>45,100</u>
------------	------------------

*OTHER CONTRACTOR

Brick & Morter	\$ 3,230	
Handling Equipment	434	
Capital Equipment	<u>840</u>	<u>5,504</u>

Total Manufacturing Facilities	\$ <u><u>50,604</u></u>
--------------------------------	-------------------------

* Facilities required to build attach structure, nose cone, aft skirt, and fitting for SRM at Michoud. These are required in addition to the facilities required for the core stage vehicle.

Estimated:	Fixed cost of	8,434	
	Variable cost of	<u>42,170</u>	←
		<u><u>50,604</u></u>	

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FINAL REPORT
FOR
COST STUDIES OF MULTIPURPOSE
LARGE LAUNCH VEHICLES

BASELINE MLLV COSTS

BOOK B OF VOLUME V

PREPARED UNDER CONTRACT NAS2-5056
FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF ADVANCE RESEARCH AND TECHNOLOGY
MISSION ANALYSIS DIVISION
SEPTEMBER 15, 1969

PREPARED BY



C. A. PENDER

J. LEE

W. RICHARD

SUPERVISED BY



JOHN R. TURNER

APPROVED BY



JOSEPH W. MONROE

THE BOEING COMPANY
SOUTHEAST DIVISION
HUNTSVILLE OPERATION
HUNTSVILLE, ALABAMA

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NOTE: This is the second book (Book B) of the three books which comprise Volume V of the final documentation for "Cost Studies of Multipurpose Large Launch Vehicles." This book contains Section 4.0, MLLV Development Test or "B" Costs. Sections 1.0 through 3.0 are in Book A, MLLV Get Ready or "A" Costs, and Section 5.0, First Unit or "C" Costs is in Book C.

The pages in this volume are numbered sequentially from Book A through Book C.

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4.0 DEVELOPMENT TEST OR "B" COSTS

This section contains a detailed breakdown of the total non-recurring development testing costs for the various configuration elements of the Multipurpose Large Launch Vehicle (MLLV) baseline family i.e.

The non-recurring costs have been categorized into the following sub-paragraphs:

- a. Single Stage-to-Orbit Vehicle (Section 4.1)
- b. Injection Stage - Engine Module (Section 4.2)
- c. Injection Stage - Fuel Module (Section 4.3)
- d. Solid Rocket Motor Stage (Section 4.4)

Costs for each of the configuration elements are categorized by the various types of testing required such as:

- a. Static Load Test
- b. Engine Installation - Manufacturing Development
- c. Manufacturing Development Test
- d. Systems Test
- e. Engine PFRT and Qualification Test
- f. Facility Checkout
- g. Manufacturing Mockup
- h. Systems Development Facility
- i. R&D Flight Vehicles
- j. Wind Tunnel Testing

For convenience and easy reference, the costs associated with the above items are displayed in Figure 4.0.0.0-1. Sub-paragraph numbers are also referenced to assist in locating the desired item(s).

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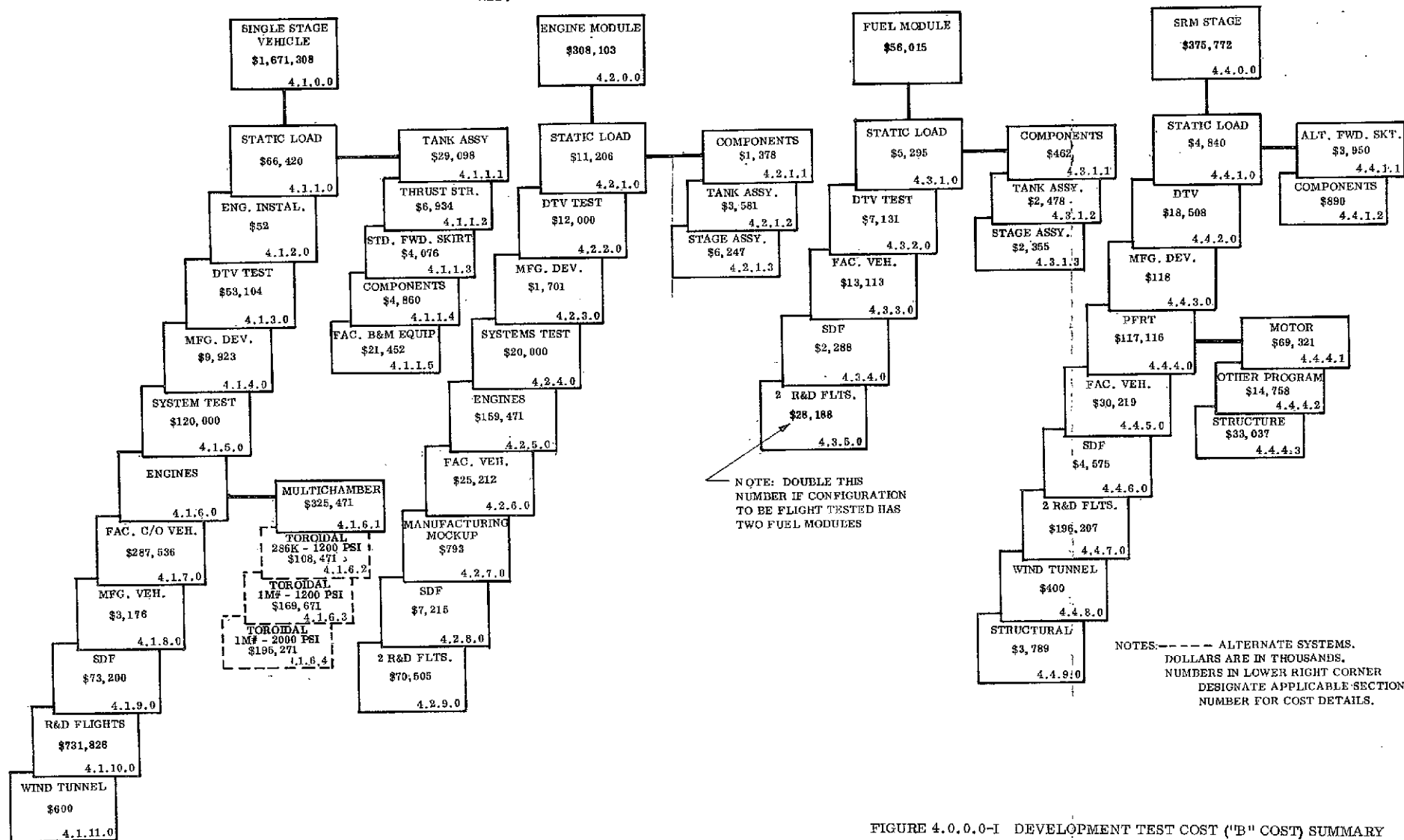


FIGURE 4.0.0.0-I DEVELOPMENT TEST COST ('B' COST) SUMMARY

4.0 (Continued)

As stated in Section 1.0 of this volume (see Book A, Volume V), the output of Phase II, Task 1 was to produce "Modularized" costs data. The "modularized" data presented in this section provide an understanding of the costs associated with all the development testing of the hardware items and will permit the evaluation of the relative impact of specific tests and/or elements on overall program costs. The development testing costs were developed in such a manner that the major vehicle options stand on their own; i.e., the costs for the single stage vehicle are the total costs for testing the single-stage-to-orbit vehicle. The costs for the injection stage - engine module; the injection stage - fuel module and the SRM's are the additional costs for testing each of these configuration elements.

Volume III - Resource Implications of this final report provides the basic overall general philosophy, ground rules and assumptions and the basic resource inputs for the development test programs. Resource and cost requirements for each of the specific tests or test categories are provided for each vehicle configuration option, in terms of (1) the facility equipment and tools required for the testing activity, and (2) the manpower, material and test specimens required to conduct each of the tests.

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4.1 SINGLE STAGE VEHICLE

The summary costs for testing the single stage MLLV vehicle are displayed in Table 4.1.0.0-I. These costs include not only the cost associated with conducting the test but all the costs of the test specimens as well. Specimen costs were developed from the recurring costs contained in Book C of this volume. Figure 4.1.0.0-1 displays the total cost of the single stage vehicle by type of test, and the appropriate sub-paragraph where the cost information is located.

TABLE 4.1.0.0-I
MLLV COST SUMMARY

SINGLE STAGE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	31	374								31	374
PROGRAM PLAN. & REPT.	79	944								79	944
INDUSTRIAL RELATIONS	18	171								18	171
ENGINEERING			590	107,773						590	107,773
LAB TECHNICIANS			507	4,924						507	4,924
TOOLING				8,100							8,100
PRODUCTION			1,231	131,769						1,231	131,769
MANUFACTURING TEST				38,000							38,000
MANUFACTURING TECH.											
Q & R A			334	3,251						334	3,251
FACILITIES											
DIRECT DIST			557	5,404						557	5,404
TRAINING			23	247						23	247
TOTAL DIRECT LABOR	128	1,489	3,242	299,468						3,370	300,957
MATERIAL		3		4239					58,771		63,013
LOGISTIC HARDWARE				*55339							55,339
BURDEN				1,439							1,439
TOTAL MATERIAL		3		61,017					58,771		119,791
TOTAL OTHER					37,397		1,213,162				1,250,559
TOTAL COST		1,492		360,486	37,397		1,271,933				1,671,308

* SPECIMEN

** PROPELLANT

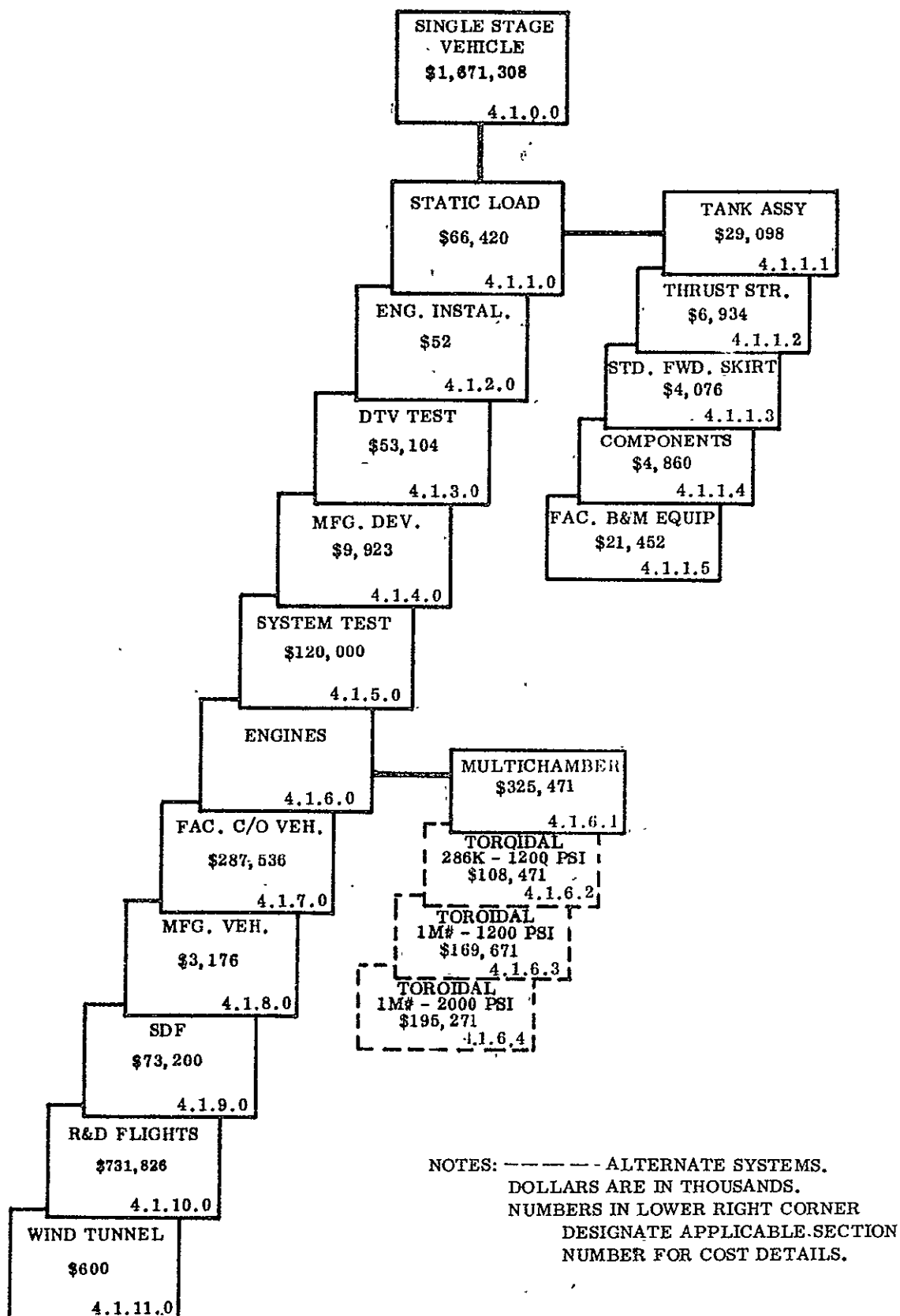


FIGURE 4.1.0.0-1 MLLV SINGLE STAGE TO ORBIT VEHICLE COST DEVELOPMENT TEST, "E" COSTS

4.1.1 Static Load Test - Single Stage Vehicle

The total costs of conducting all of the static load tests for the single stage vehicle are displayed in Table 4.1.1.0-I. In addition, Figure 4.1.1.0-1 displays the overall test costs and appropriate sub-section number for the various components that require static testing.

Sections 4.1.1.1 through 4.1.1.4, which reflect the test costs for the tank assembly, thrust structure, standard forward skirt and the other components, include the costs of the labor, material, and tooling for the following:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture fabrication
4. Load fixture installation
5. Plumbing installation
6. Instrumentation installation
7. Mechanical checkout
8. Electrical checkout
9. Conduct the test
10. Teardown effort

4.1.1 (Continued)

c. Material and Parts

1. Raw material
2. Mechanical components
3. Electrical transducers
4. Electrical components and equipment
5. Test specimen (from "C" cost)

d. Retest Allowance

Parts, materials and labor costs

Section 4.1.1.5 reflects the cost of the static load test facilities and the capital equipment for conducting the tests. In addition, the maintenance costs for the facilities and capital equipment are also included.

TABLE 4.1.1.0-I

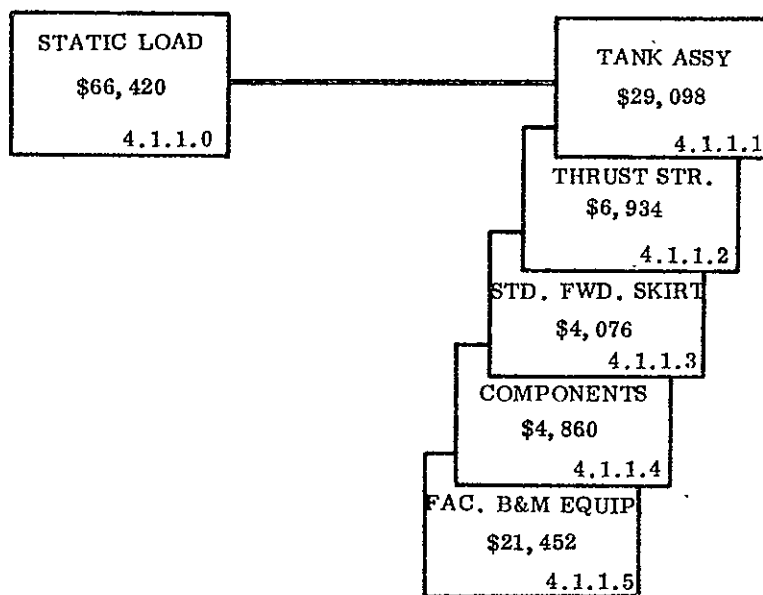
MLLV COST SUMMARY

STATIC LOAD TEST - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	10	127								10	127
PROGRAM PLAN. & REPT.	26	311								26	311
INDUSTRIAL RELATIONS	7	56								7	56
ENGINEERING			294	3,477						294	3,477
LAB TECHNICIANS											
TOOLING											
PRODUCTION			556	5,408						556	5,408
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			28	269						28	269
FACILITIES											
DIRECT DIST			179	1,730						179	1,730
TRAINING			7	80						7	80
TOTAL DIRECT LABOR	43	494	1,064	10,964						1,107	11,458
MATERIAL				1,220							1,220
LOGISTIC HARDWARE				31,875							31,875
BURDEN				414							414
TOTAL MATERIAL				33,510							33,510
TOTAL OTHER					21,452						21,452
TOTAL COST		494		44,474	21,452						66,420



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 4.1.1.0-1 MLLV MAIN STAGE STATIC LOAD TEST COSTS DEVELOPMENT
 TEST, "B" COSTS

4.1.1.1 Tank Assembly – Static Load Test

TABLE 4.1.1.1-I

MLLV COST SUMMARY STATIC LOAD TEST - TANK ASSEMBLY - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	55								4	55
PROGRAM PLAN. & REPT.	11	130								11	130
INDUSTRIAL RELATIONS	3	23								3	23
ENGINEERING			123	1,457						123	1,457
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST			233	2,265						233	2,265
MANUFACTURING TECH.											
Q & R A			12	113						12	113
FACILITIES											
DIRECT DIST			75	725						75	725
TRAINING			3	33						3	33
TOTAL DIRECT LABOR	18	208	446	4,593						464	4,801
MATERIAL				622							622
LOGISTIC HARDWARE				23,464							23,464
BURDEN				211							211
TOTAL MATERIAL				24,297							24,297
TOTAL OTHER											
TOTAL COST		208		28,890							29,098

MLLV
NON-RECURRING

PART I

STATIC LOAD TEST - TANK ASSEMBLY - S/S

ASSEMBLY OR SYSTEM

TABLE 4.1.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>123,352</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u> </u>		
Tooling	<u> </u>		
Manufacturing Test	<u>233,020</u>		
Q&RA	<u>11,652</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>368,024</u>		
Program Executive		<u>4,416</u>	<u>\$ 52,153</u>
Program Planning & Reporting		<u>11,040</u>	<u>130,382</u>
Industrial Relations		<u>2,392</u>	<u>23,250</u>
Total Labor - Part I		<u>17,848</u>	<u>\$207,785</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 220</u>
Industrial Relations			<u>239</u>
Material Subtotal			<u>459</u>
Material & Administrative Burden			<u>156</u>
Total Material			<u>\$ 615</u>
TOTAL COST - PART I			<u>\$208,400</u>

TABLE 4.1.1.1-III

MLLV PART II COST SUMMARY TANK ASSEMBLY / - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	123	1,457							123	1,457
LAB TECHNICIANS										
TOOLING										
PRODUCTION										
MANUFACTURING TEST							233	2,265	233	2,265
MANUFACTURING TECH.										
Q & R A							12	113	12	113
DIRECT DIST							75	725	75	725
TRAINING							3	33	3	33
TOTAL DIRECT LABOR	123	1,457					323	3,136	446	4,593
MATERIAL				*23,464						23,464
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								619		619
MFG. TECHNICIANS										
Q & R A								3		3
SUBTOTAL				23,464				622		24,086
MAT. & ADM. BURDEN								211		211
TOTAL MATERIAL				23,464				833		24,297
TOTAL PART II COST		1,457		23,464				3,969		28,890

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

TANK ASSEMBLY - S/S
CONDUCT STATIC LOAD TEST
TABLE 4.1.1.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	108,800	\$1,285
Retest Allowance	<u>14,552</u>	<u>172</u>
TOTAL COST	<u>123,352</u>	<u>\$1,457</u>

MLLV
R & D TEST COST
NON-RECURRING

TANK ASSEMBLY S/S
CONDUCT STATIC LOAD TEST
TABLE 4.1.1.1-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	190,648	\$1,853
(2) Retest Allowance	43,372	411
Subtotal "A"	233,020	\$2,265
(3) Direct Distributable	74,566	725
Subtotal "B"	307,586	\$2,990
(4) Training	3,383	33
Subtotal "C"	310,969	\$3,023
(5) Q&RA	11,652	113
TOTAL LABOR	322,621	\$3,136
<u>Material</u>		
(6) Raw Material & Parts		\$ 619
(7) Q&RA		3
Material Subtotal		\$ 621
(8) Material & Admin. Burden		211
TOTAL MATERIAL		\$ 832
TOTAL COST		\$3,968

4.1.1.2 Thrust Structure - Static Load Test

TABLE 4.1.1.2-I

MLLV COST SUMMARY

STATIC LOAD TEST - THRUST STRUCTURE - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	35								3	35
PROGRAM PLAN. & REPT.	7	87								7	87
INDUSTRIAL RELATIONS	2	16								2	16
ENGINEERING			83	975						83	975
LAB TECHNICIANS											
TOOLING											
PRODUCTION			156	1,519						156	1,519
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			8	75						8	75
FACILITIES											
DIRECT DIST			50	485						50	485
TRAINING			2	23						2	23
TOTAL DIRECT LABOR	12	138	299	3,077						311	3,215
MATERIAL				416							416
LOGISTIC HARDWARE				3,162							3,162
BURDEN				141							141
TOTAL MATERIAL				3,719							3,719
TOTAL OTHER											
TOTAL COST		138		6,796							6,934

MLLV
NON-RECURRING
PART I

STATIC LOAD TEST - THRUST STRUCTURE - S/S
ASSEMBLY OR SYSTEM
TABLE 4.1.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>82,573</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>156,229</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>7,811</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>246,613</u>		
Program Executive		<u>2,959</u>	<u>\$ 34,946</u>
Program Planning & Reporting		<u>7,398</u>	<u>87,370</u>
Industrial Relations		<u>1,603</u>	<u>15,581</u>
Total Labor - Part I		<u>11,960</u>	<u>\$137,897</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 148</u>
Industrial Relations			<u>160</u>
Material Subtotal			<u>\$ 308</u>
Material & Administrative Burden			<u>105</u>
Total Material			<u>\$ 413</u>
TOTAL COST - PART I			<u>\$138,292</u>

TABLE 4.1.1.2-III

MLLV PART II COST SUMMARY STATIC LOAD TEST - THRUST STRUCTURE S/S A ☐ B ☒ C ☐ (IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	83	975							83	975
LAB TECHNICIANS										
TOOLING										
PRODUCTION							156	1,519	156	1,519
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							8	75	8	75
DIRECT DIST							50	485	50	485
TRAINING							2	23	2	23
TOTAL DIRECT LABOR	83	975					216	2,102	299	3,077
MATERIAL				*3,162						3,162
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								414		414
MFG. TECHNICIANS										
Q & R A								2		2
SUBTOTAL								416		3,578
MAT. & ADM. BURDEN								141		141
TOTAL MATERIAL				3,162				557		3,719
TOTAL PART II COST		975		3,162				2,659		6,796

* Specimen

MLLV
R & D TEST COST
NON-RECURRING

THRUST STRUCTURE - S/S
CONDUCT STATIC LOAD TEST
TABLE 4.1.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	72,600	\$857
Retest Allowance	<u>9,973</u>	<u>118</u>
TOTAL COST	<u>82,573</u>	<u>\$975</u>

MLLV
R & D TEST COST
NON-RECURRING

THRUST STRUCTURE - S/S
CONDUCT STATIC LOAD TEST

TABLE 4.1.1.2-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	127,189	\$1,236
(2) Retest Allowance	29,040	283
Subtotal "A"	156,229	\$1,519
(3) Direct Distributable	49,993	485
Subtotal "B"	206,222	\$2,004
(4) Training	2,268	23
Subtotal "C"	208,490	\$2,027
(5) Q&RA	7,811	75
TOTAL LABOR	<u>216,301</u>	<u>\$2,102</u>
<u>Material</u>		
(6) Raw Material & Parts		\$ 414
(7) Q&RA		2
Material Subtotal		<u>\$ 416</u>
(8) Material & Admin. Burden		141
TOTAL MATERIAL		<u>\$ 557</u>
TOTAL COST		<u>\$2,659</u>

4.1.1.3 Standard Forward Skirt (Lightweight Skirt) -
Static Load Test

TABLE 4.1.1.3-I
MLLV COST SUMMARY

STATIC LOAD TEST
FORWARD SKIRT - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	17								1	17
PROGRAM PLAN. & REPT.	4	44								4	44
INDUSTRIAL RELATIONS	1	8								1	8
ENGINEERING			41	489						41	489
LAB TECHNICIANS											
TOOLING											
PRODUCTION			78	759						78	759
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			4	38						4	38
FACILITIES											
DIRECT DIST			25	243						25	143
TRAINING			1	11						1	11
TOTAL DIRECT LABOR	6	69	149	1,540						155	1,609
MATERIAL				85							85
LOGISTIC HARDWARE				2,353							2,353
BURDEN				29							29
TOTAL MATERIAL				2,467							2,467
TOTAL OTHER											
TOTAL COST		69		4,007							4,076

MLLV
NON-RECURRING

PART I

STATIC LOAD TEST - FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM

1ST UNIT COST

TABLE 4.1.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>41,387</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>78,114</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>3,906</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>123,407</u>		
Program Executive		<u>1,481</u>	<u>\$17,491</u>
Program Planning & Reporting		<u>3,702</u>	<u>43,721</u>
Industrial Relations		<u>802</u>	<u>7,795</u>
Total Labor - Part I		<u>5,985</u>	<u>\$69,007</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 72</u>
Industrial Relations			<u>80</u>
Material Subtotal			<u>152</u>
Material & Administrative Burden			<u>52</u>
Total Material			<u>\$ 204</u>
TOTAL COST - PART I			<u>\$69,211</u>

TABLE 4.1.1.3-III

MLLV PART II COST SUMMARY

FORWARD SKIRT - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	41	489							41	489
LAB TECHNICIANS										
TOOLING										
PRODUCTION							78	759	78	759
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							4	38	4	38
DIRECT DIST							25	243	25	243
TRAINING							1	11	1	11
TOTAL DIRECT LABOR	41	489					108	1,051	149	1,540
MATERIAL				*2,353						2,353
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS								84		84
Q & R A								1		1
SUBTOTAL				2,353				85		2,438
MAT. & ADM. BURDEN								29		29
TOTAL MATERIAL				2,353				114		2,467
TOTAL PART II COST		489		2,353				1,165		4,007

* Specimen

MLLV
R & D TEST COST
NON-RECURRING

FORWARD SKIRT - S/S
CONDUCT STATIC LOAD TEST

TABLE 4.1.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars.</u>
Engineering	36,400	\$430
Retest Allowance	<u>4,987</u>	<u>59</u>
TOTAL COST	<u><u>41,387</u></u>	<u><u>\$489</u></u>

MLLV
R & D TEST COST
NON-RECURRING

FORWARD SKIRT - S/S
CONDUCT STATIC LOAD TEST

TABLE 4.1.1.3-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	63,594	\$ 618
(2) Retest Allowance	14,520	141
Subtotal "A"	78,114	\$ 759
(3) Direct Distributable	24,996	243
Subtotal "B"	103,110	\$1,002
(4) Training	1,134	11
Subtotal "C"	104,244	\$1,013
(5) Q&RA	3,906	38
TOTAL LABOR	<u>108,150</u>	<u>\$1,051</u>
<u>Material</u>		
(6) Raw Material & Parts		\$ 84
(7) Q&RA		1
Material Subtotal		\$ 85
(8) Material & Admin. Burden		29
TOTAL MATERIAL		<u>\$ 114</u>
TOTAL COST		<u>\$1,165</u>

4.1.1.4 Component Testing – Static Load Test

TABLE 4.1.1.4-I

MLLV COST SUMMARY STATIC TEST - COMPONENTS - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	20								2	20
PROGRAM PLAN. & REPT.	4	50								4	50
INDUSTRIAL RELATIONS	1	9								1	9
ENGINEERING			47	556						47	556
LAB TECHNICIANS											
TOOLING											
PRODUCTION			89	865						89	865
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			4	43						4	43
FACILITIES											
DIRECT DIST			29	277						29	277
TRAINING			1	13						1	13
TOTAL DIRECT LABOR	7	79	170	1,754						177	1,833
MATERIAL				97							97
LOGISTIC HARDWARE				2,897							2,897
BURDEN				33							33
TOTAL MATERIAL				3,027							3,027
TOTAL OTHER											
TOTAL COST		79		4,781							4,860

MLLV
NON-RECURRING

PART I

STATIC LOAD TEST - COMPONENTS - S/S..

ASSEMBLY OR SYSTEM

1ST UNIT COST

TABLE 4.1.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>47,078</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>89,031</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>4,452</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>140,561</u>		
Program Executive		<u>1,687</u>	<u>\$19,923</u>
Program Planning & Reporting		<u>4,217</u>	<u>49,803</u>
Industrial Relations		<u>914</u>	<u>8,884</u>
Total Labor - Part I		<u>6,818</u>	<u>\$78,610</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 84</u>
Industrial Relations			<u>91</u>
Material Subtotal			<u>175</u>
Material & Administrative Burden			<u>60</u>
Total Material			<u>\$ 235</u>
TOTAL COST - PART I			<u>\$78,845</u>

TABLE 4.1.1.4-III

MLLV PART II COST SUMMARY

COMPONENTS - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	47	556							47	556
LAB TECHNICIANS										
TOOLING										
PRODUCTION							89	865	89	865
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							4	43	4	43
DIRECT DIST							28	277	28	277
TRAINING							1	13	1	13
TOTAL DIRECT LABOR	47	556					123	1,198	170	1,754
MATERIAL				*2,897						2,897
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								96		96
MFG. TECHNICIANS										
Q & R A								1		1
SUBTOTAL				2,897				97		2,994
MAT. & ADM. BURDEN								33		33
TOTAL MATERIAL				2,897				130		3,027
TOTAL PART II COST		556		2,897				1,328		4,781

* Specimen

MLLV
R & D TEST COST
NON-RECURRING

COMPONENTS - S/S
CONDUCT STATIC LOAD TEST
TABLE 4.1.1.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	41,400	\$489
Retest Allowance	<u>5,678</u>	<u>67</u>
TOTAL COST	<u><u>47,078</u></u>	<u><u>\$556</u></u>

MLLV
R & D TEST COST
NON-RECURRING

COMPONENTS - S/S

CONDUCT STATIC LOAD TEST

TABLE 4.1.1.4-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	72,498	\$ 705
(2) Retest Allowance	16,533	160
Subtotal "A"	89,031	\$ 865
(3) Direct Distributable	28,490	277
Subtotal "B"	117,521	\$1,142
(4) Training	1,293	13
Subtotal "C"	118,814	\$1,155
(5) Q&RA	4,452	43
TOTAL LABOR	<u>123,266</u>	<u>\$1,198</u>
<u>Material</u>		
(6) Raw Material & Parts		\$ 96
(7) Q&RA		1
Material Subtotal		<u>\$ 97</u>
(8) Material & Admin. Burden		33
TOTAL MATERIAL		<u>\$ 130</u>
TOTAL COST		<u>\$1,328</u>

4.1.1.5 Static Test Facility, Capital Equipment and Maintenance

TABLE 4.1.1.5-I
MLLV COST SUMMARY

STATIC LOAD TEST
FAC. & B&M, EQUIP. - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER						21,452					21,452
TOTAL COST						21,452					21,452

MLIV
R&D TEST FACILITIES
STATIC LOAD TEST - SINGLE STAGE

TABLE 4.1.1.5-II

	Dollars (In Thousands)
Brick and Mortar	20,444
Maintenance (one year)	<u>1,008</u>
Total Cost	<u><u>21,452</u></u>

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4.1.2 Engine Installation - Manufacturing Development

This cost covers the effort that is required to develop the processes that are necessary to assure reliable installation of the engines on the single stage. Table 4.1.2.0-I reflects the cost of this function.

TABLE 4.1.2.0-I
MLLV COST SUMMARY

MANUFACTURING DEVELOPMENT
ENGINE INSTALLATION - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		2									2
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION			3	27						3	27
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A				7							7
FACILITIES											
DIRECT DIST			1	8						1	8
TRAINING											
TOTAL DIRECT LABOR		2	4	42						4	44
MATERIAL				6							6
LOGISTIC HARDWARE											
BURDEN				2							2
TOTAL MATERIAL				8							8
TOTAL OTHER											
TOTAL COST		2		50							52

MLLV
DEVELOPMENT COST
NON-RECURRING
PART I

MANUFACTURING DEVELOPMENT - S/S
ENGINE INSTALLATION
TABLE 4.1.2.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
Direct Labor			
Engineering			
Lab. Tech.	2,731		
Manufacturing			
Q&RA	710		
	<hr/>		
Total Direct Labor	3,441		
	<hr/>		
Program Executive		41	484
Program Planning & Reporting		104	1,228
Industrial Relations		23	224
		<hr/>	<hr/>
Total Labor Part I		168	1,936
		<hr/>	<hr/>
Material			
Program Planning & Reporting			2
Industrial Relations			2
			<hr/>
Material Subtotal			4
Material & Admin. Burden			1
			<hr/>
Total Material			5
			<hr/>
TOTAL COST PART I			1,941
			<hr/>

TABLE 4.1.2.0-III

MLLV PART II COST SUMMARY ENGINE INSTALLATION - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING			3	27					3	27
LAB TECHNICIANS										
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A				7						7
DIRECT DIST			1	8					1	8
TRAINING										
TOTAL DIRECT LABOR			4	42					4	42
MATERIAL				6						6
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				6						6
MAT. & ADM. BURDEN				2						2
TOTAL MATERIAL				8						8
TOTAL PART II COST				50						50

MLLV
DEVELOPMENTAL COST
NON-RECURRING

MANUFACTURING DEVELOPMENT
ENGINE INSTALLATION

TABLE 4.1.2.0-IV

<u>ELEMENT OF COST</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
Laboratory Technician	2,731	\$26,545
Direct Distributable	<u>874</u>	<u>8,495</u>
Subtotal	3,605	\$35,040
Training	<u>40</u>	<u>388</u>
Subtotal	3,645	\$35,428
Quality and Reliability Assurance	<u>729</u>	<u>7,085</u>
TOTAL LABOR	<u><u>4,374</u></u>	<u><u>\$42,513</u></u>
<u>MATERIAL</u>		
Laboratory Technician		\$ 6,000
Material and Administrative Burden		<u>2,040</u>
TOTAL MATERIAL		<u><u>\$ 8,040</u></u>
TOTAL COST		<u><u>\$50,553</u></u>

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4.1.3 Dynamic Testing - Single Stage Vehicle

The total cost for performing the dynamic tests on the single stage vehicle are displayed in Table 4.1.3.0-I. This includes the labor, material, tooling, facilities and equipment to accomplish the following functions:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture - fabrication and installation
4. Plumbing installation
5. Instrumentation installation
6. Mechanical checkout
7. Electrical checkout
8. Conduct the test
9. Teardown effort

c. Material and Parts

1. Raw materials
2. Mechanical components

4.1.3 (Continued)

3. Electrical transducers
4. Electrical components and equipment
5. Test specimen (from "C" costs)

d. Retest Allowance

Parts, materials and labor costs

The cost of maintaining the facilities and capital equipment are also included. The maintenance cost covers the time period of the test cycle - 9 months.

TABLE 4.1.3.0-I

MLLV COST SUMMARY DYNAMIC TEST - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	11	131								11	131
PROGRAM PLAN. & REPT.	28	328								28	328
INDUSTRIAL RELATIONS	6	59								6	59
ENGINEERING			296	3,496						296	3,496
LAB TECHNICIANS											
TOOLING											
PRODUCTION			504	4,900						504	4,900
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			126	1,225						126	1,225
FACILITIES											
DIRECT DIST			161	1,568						161	1,568
TRAINING			7	71						7	71
TOTAL DIRECT LABOR	45	518	1,094	11,260						1,139	11,778
MATERIAL		2		1,429							1,431
LOGISTIC HARDWARE				*23464							23,464
BURDEN				486							486
TOTAL MATERIAL		2		25,379							25,381
TOTAL OTHER						15,945					15,945
TOTAL COST		520		36,639		15,945					53,104

* SPECIMEN

MLLV

PART I

DYNAMIC TEST - S/S
ASSEMBLY OR SYSTEM

TABLE 4.1.3.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	296,061		
Logistics			
Laboratory Technician			
Production	504,086		
Tooling			
Manufacturing Test			
Q&RA	126,022		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>926,169</u>		
Program Executive		11,114	131,256
Program Planning & Reporting		27,785	328,140
Industrial Relations		6,020	58,514
Total Labor - Part I		<u>44,919</u>	<u>517,911</u>
<u>Material</u>			
Program Planning & Reporting			555
Industrial Relations			602
Material Subtotal			<u>1,157</u>
Material & Administrative Burden			<u>393</u>
Total Material			<u>1,551</u>
TOTAL COST - PART I			<u>519,462</u>

TABLE 4.1.3.0-III

MLLV PART II COST SUMMARY DYNAMIC TEST - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	296	3,496							296	3,496
LAB TECHNICIANS										
TOOLING										
PRODUCTION							504	4,900	504	4,900
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							126	1,225	126	1,225
DIRECT DIST							161	1,568	161	1,568
TRAINING							7	71	7	71
TOTAL DIRECT LABOR	296	3,496					799	7,764	1,095	11,260
MATERIAL				*23,464						23,464
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								1,391		1,391
MFG. TECHNICIANS										
Q & R A								38		38
SUBTOTAL				23,464				1,429		24,893
MAT. & ADM. BURDEN								486		486
TOTAL MATERIAL				23,464				1,915		25,379
TOTAL PART II COST		3,496		23,464				9,679		36,639

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

CONDUCT DYNAMIC TEST - S/S
TABLE 4.1.3.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	<u>258,933</u>	<u>3,058</u>
Retest Allowance	<u>37,128</u>	<u>438</u>
TOTAL COST	<u>296,061</u>	<u>3,496</u>

MLLV
R & D TEST COST
NON-RECURRING

CONDUCT DYNAMIC TEST - S/S
TABLE 4.1.3.0-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	395,978	3,849
(2) Retest Allowance	108,108	1,051
Subtotal	504,086	4,900
(3) Direct Distributable	161,308	1,568
Subtotal	665,394	6,468
(4) Training	7,319	71
Subtotal	672,713	6,539
(5) Q&RA	126,022	1,225
TOTAL LABOR	<u>798,735</u>	<u>7,764</u>
<u>Material</u>		
(6) Raw Material & Parts		1,391
(7) Q&RA		38
Material Subtotal		<u>1,429</u>
(8) Material & Admin. Burden		486
TOTAL MATERIAL		<u>1,915</u>
TOTAL COST		<u>9,679</u>

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4.1.4 Manufacturing Development Test - Single Stage Vehicle

The manufacturing development task is directed toward the development and implementation of fabrication and assembly processes to produce the single stage vehicles.

Defined in broad terms, the procedure is as follows:

- a. Determine manufacturing development requirements through coordination and review of engineering drawings and specifications, present methods and existing manufacturing capabilities.
- b. Establish suitable manufacturing methods. Document and coordinate these methods with applicable organizations.
- c. Define equipment requirements, tooling criteria, training requirements, and establish step-by-step procedures for critical manufacturing.
- d. Coordinate with factory, manufacturing engineerings, facilities training, etc., to assist them in the implementation and proper application of newly developed methods.

Table 4.1.4.0-F displays the cost associated with this function for the single stage vehicle.

TABLE 4.1.4.0-I

MLLV COST SUMMARY

MANUFACTURING DEVELOPMENT - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	7	84								7	84
PROGRAM PLAN. & REPT.	19	230								19	230
INDUSTRIAL RELATIONS	4	42								4	42
ENGINEERING											
LAB TECHNICIANS			507	4,924						507	2,924
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			135	1,314						135	1,314
FACILITIES											
DIRECT DIST			162	1,575						162	1,575
TRAINING			7	72						7	72
TOTAL DIRECT LABOR	30	356	811	7,885						841	8,241
MATERIAL		1		1,254							1,255
LOGISTIC HARDWARE											
BURDEN				427							427
TOTAL MATERIAL		1		1,681							1,682
TOTAL OTHER											
TOTAL COST		357		9,566							9,923

MLLV

PART I

MANUFACTURING DEVELOPMENT - S/S
ASSEMBLY OR SYSTEM

TABLE 4.1.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician	506,559		
Production			
Tooling			
Manufacturing Test			
Q&RA	135,203		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>641,762</u>		
Program Executive		7,071	83,509
Program Planning & Reporting		19,484	230,106
Industrial Relations		<u>4,348</u>	<u>42,263</u>
Total Labor - Part I		<u>30,903</u>	<u>355,878</u>
<u>Material</u>			
Program Planning & Reporting			390
Industrial Relations			<u>434</u>
Material Subtotal			824
Material & Administrative Burden			<u>240</u>
Total Material			<u>1,104</u>
TOTAL COST - PART I			<u>356,982</u>

TABLE 4.1.4.0-III

MLLV PART II COST SUMMARY MANUFACTURING DEVELOPMENT - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS			507	4,924					507	4,924
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			135	1,314					135	1,314
DIRECT DIST			162	1,575					162	1,575
TRAINING			7	72					7	72
TOTAL DIRECT LABOR			811	7,885					811	7,885
MATERIAL										
LAB. TECHNICIANS				1,213						1,213
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				41						41
SUBTOTAL				1,254						1,254
MAT. & ADM. BURDEN				427						427
TOTAL MATERIAL				1,681						1,681
TOTAL PART II COST				9,566						9,566

MLLV
DEVELOPMENTAL COST
NON-RECURRING
MANUFACTURING DEVELOPMENT - S/S

TABLE 4.1.4.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u> (In Thousands)
Lab Technician	506,559	4,924
Direct Distributable	<u>162,099</u>	<u>1,575</u>
Subtotal	668,658	6,499
Training	<u>7,355</u>	<u>72</u>
Subtotal	676,013	6,571
Q&RA	<u>135,203</u>	<u>1,314</u>
Total Labor	<u>811,216</u>	<u>7,885</u>
Material		
Lab Technician		1,213
Q&RA		<u>41</u>
Material Subtotal		1,254
Material & Admin.Burden		<u>427</u>
Total Material		<u>1,681</u>
TOTAL COST		<u>9,566</u>

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4.1.5 Systems Test - Single Stage Vehicle

Systems tests are identified as those tests that are required in addition to the major testing (dynamic static load, flight, etc., that are displayed elsewhere in Section 4.0). It was not possible to define all of the specific tests that fall within this category; however, the requirements for this general category were estimated in terms of overall program costs by applying historical data to the overall cost of producing the first flight vehicle.

Historical data relative to research and development testing of components and subsystems for other programs, prior to and inclusive of the S-IC program, were used as a basis for cost estimates for the single stage.

Table 4.1.5.0-I shows the resulting cost estimates for component and subsystem testing of the single stage.

Systems test include (but are not limited to):

- a. On-board test and checkout
- b. Qualification testing
- c. Acoustics testing, etc.

TABLE 4.1.5.0-I

MLLW COST SUMMARY

SYSTEMS TEST - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									120,000		120,000
TOTAL COST									120,000		120,000

MLLV
DEVELOPMENTAL TESTING COST
NON-RECURRING
SYSTEMS TEST

TABLE 4.1.5.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Miscellaneous Test include: On board test & C/O system development. Qualification testing Acoustics testing, etc.	
Single Stage Cost (1)	\$120,000

(1) Cost based on Engineering estimate.

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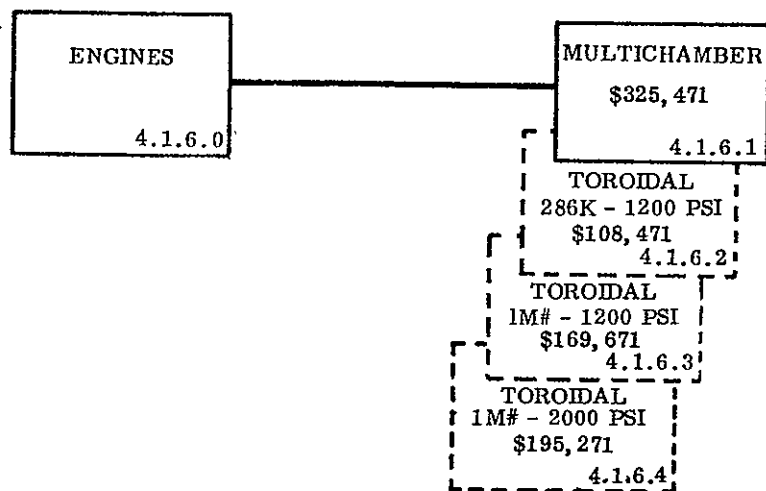
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4.1.6 Engine PFRT and Qualification Testing - Main Stage

This section shows the development test costs for the following types of engines:

- 4.1.6.1 Multichamber/Plug (with 24 modules having single position nozzles and a vacuum thrust of 388,000 pounds)
- 4.1.6.2 Toroidal/aerospike (1200 psia with 28 modules, each producing 286K pound thrust at sea level)
- 4.1.6.3 Toroidal/aerospike (1200 psia with 8 modules, each producing one million pound thrust at sea level)
- 4.1.6.4 Toroidal/aerospike (2000 psia with 8 modules, each producing one million pound thrust at sea level)

Figure 4.1.6.0-1 shows the MLLV main stage liquid engine propulsion system costs. The multichamber/plug propulsion system is shown as the engine system on the main stage with the three toroidal/aerospike systems as alternative propulsion systems.



NOTES: ALTERNATE SYSTEMS.
 DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 4.1.6.0-1 MLLV MAIN STAGE ENGINE OPTIONS COST DEVELOPMENT
 TEST, "B" COST

4.1.6.1 Multichamber/Plug Engine - Main Stage

Parametric cost data was received from Pratt and Whitney for the multichamber/plug propulsion system. This data covered a range of propulsion system sizes from above the requirements for a full size AMLLV engine to below that of a half size (MLLV) engine (Figure 4.1.6.1-1). The data received included the total cost for engine development, PFRT and qualification testing as a function of module vacuum thrust.

As stated in Section 1.0, of Book A, the program development costs (for the purpose of this study) were sub-divided into two categories: (1) Get Ready or "A" costs and (2) Developmental Testing or "B" costs. Since the parametric data (Figure 4.1.6.1-1) included costs associated with both categories, it was necessary to establish the appropriate costs associated for each of the categories. The allocation pertaining to development test costs will be discussed herein (the get ready costs were discussed in Book A). The only cost data received, that reflected program costs for engine development, (by "A" and "B" cost categories) was that submitted by Rocketdyne on the 1200 psia toroidal/aerospike engine system. Figure 4.1.6.1-2 displays, in terms of percentages, the elements of cost developed from this data.

The percentages developed were then applied to the multichamber/plug propulsion system total development costs to divide it into get ready and development test costs. The example below illustrates how these costs were divided.

Example: Pratt and Whitney total cost \$345 million X 77.3% (from Figure 4.1.6.1-2)
= \$266.7M development test cost (the remainder being used in the
get ready or "A" cost).

Table 4.1.6.1-I displays the results of this computation. These costs were also supplemented by other costs for facilities and capital equipment.

Figure 4.1.6.1-3 reflects the parametric data received from Pratt and Whitney for propellant consumption during the engine development program. The propellant data was provided in millions of pounds of propellant as a function of module vacuum thrust/thousands of pounds. This data was then converted to total dollars and was used on all three engine systems.

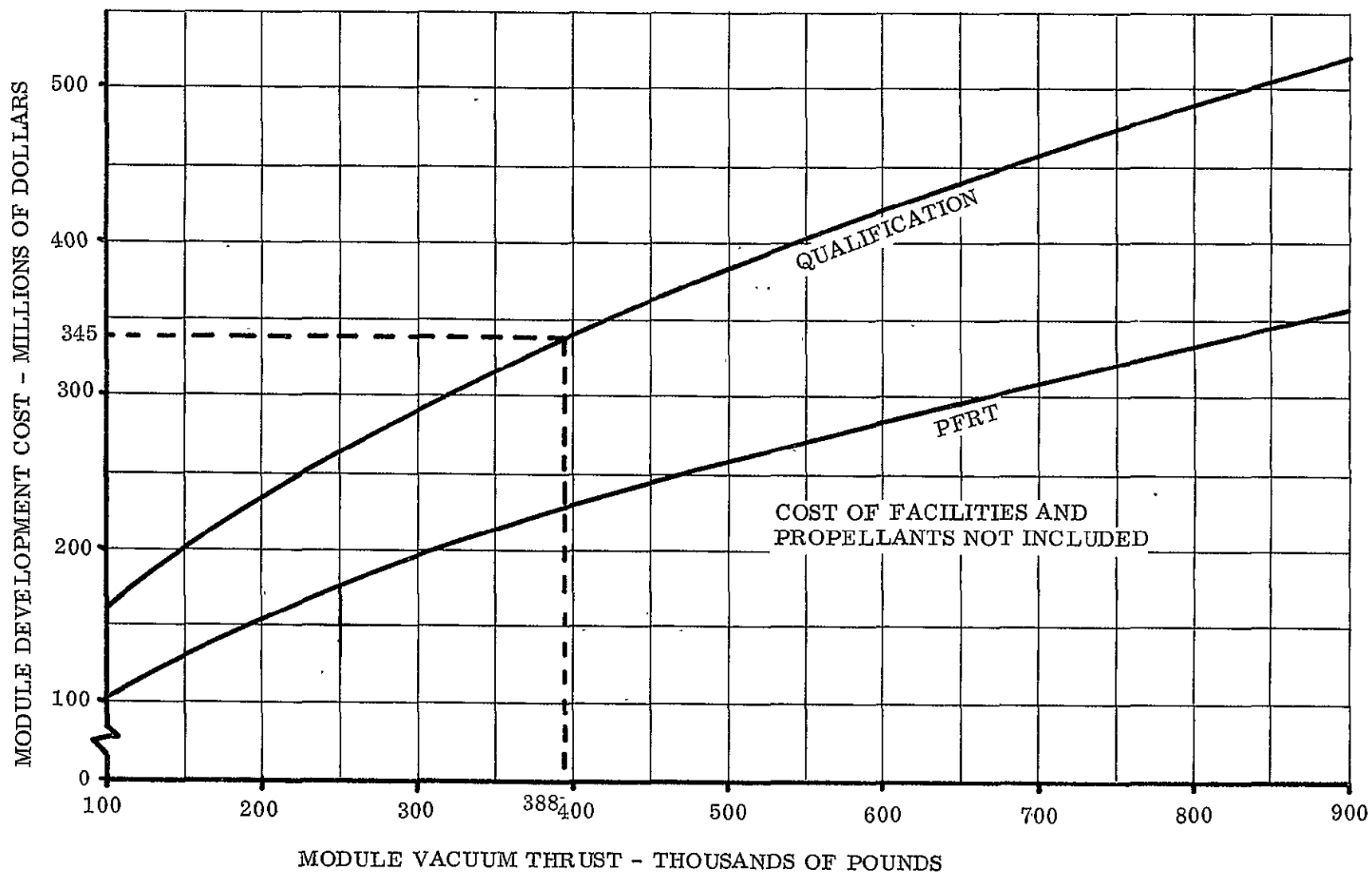


FIGURE 4.1.6.1-1 MLLV MAIN STAGE PROPULSION SYSTEM - ESTIMATED MODULE DEVELOPMENT COSTS. OXYGEN/HYDROGEN MULTICHAMBER/PLUG PROPULSION SYSTEM (PRATT & WHITNEY DATA)

	Get Ready or "A" Percentages	Development Test or "B" Percentages			
		Component	Engine	PFRT	Qual.
Design and Development					
Engineering	72.2%	46.8%	34.7%	35.1%	35.1%
Test	-0-	22.6	12.7	8.8	8.8
Equipment	2.5%	4.0	5.8	-0-	-0-
Tooling (Basic)	25.3	4.0	3.9	-0-	-0-
Fabrication	-0-	22.6	42.9	56.1	56.1
Subtotal	100% 46.8%	100% 24.9%	100% 52.1%	100% 11.5%	100% 11.5%
Production (Non-Recurring)					
Tooling (Basic)	55.5%				
Equipment	16.7%				
GSE	27.8%				
Subtotal	100% 53.2%				
	22.7%		77.3%		
Total		100%			

NOTE: Percentages based on 1200 psia 286K pound thrust module, as submitted by Rocketdyne, in memo No. 68 RC-16347 dated December 20, 1968.

These percentages were:

1. Used as is for the 1200 psia, 286K thrust engine
2. Used to allocate the amount applicable to "A" and "B" cost categories on the multichamber/plug engine

FIGURE 4.1.6.1-2 DEVELOPMENT COST FOR 1200 PSIA TOROIDAL/AEROSPIKE PROPULSION SYSTEM
DIVIDED INTO PERCENTAGES OF GET READY AND DEVELOPMENT TEST COST-
BASED ON 1200 PSIA - 286,000 POUND THRUST MODULE

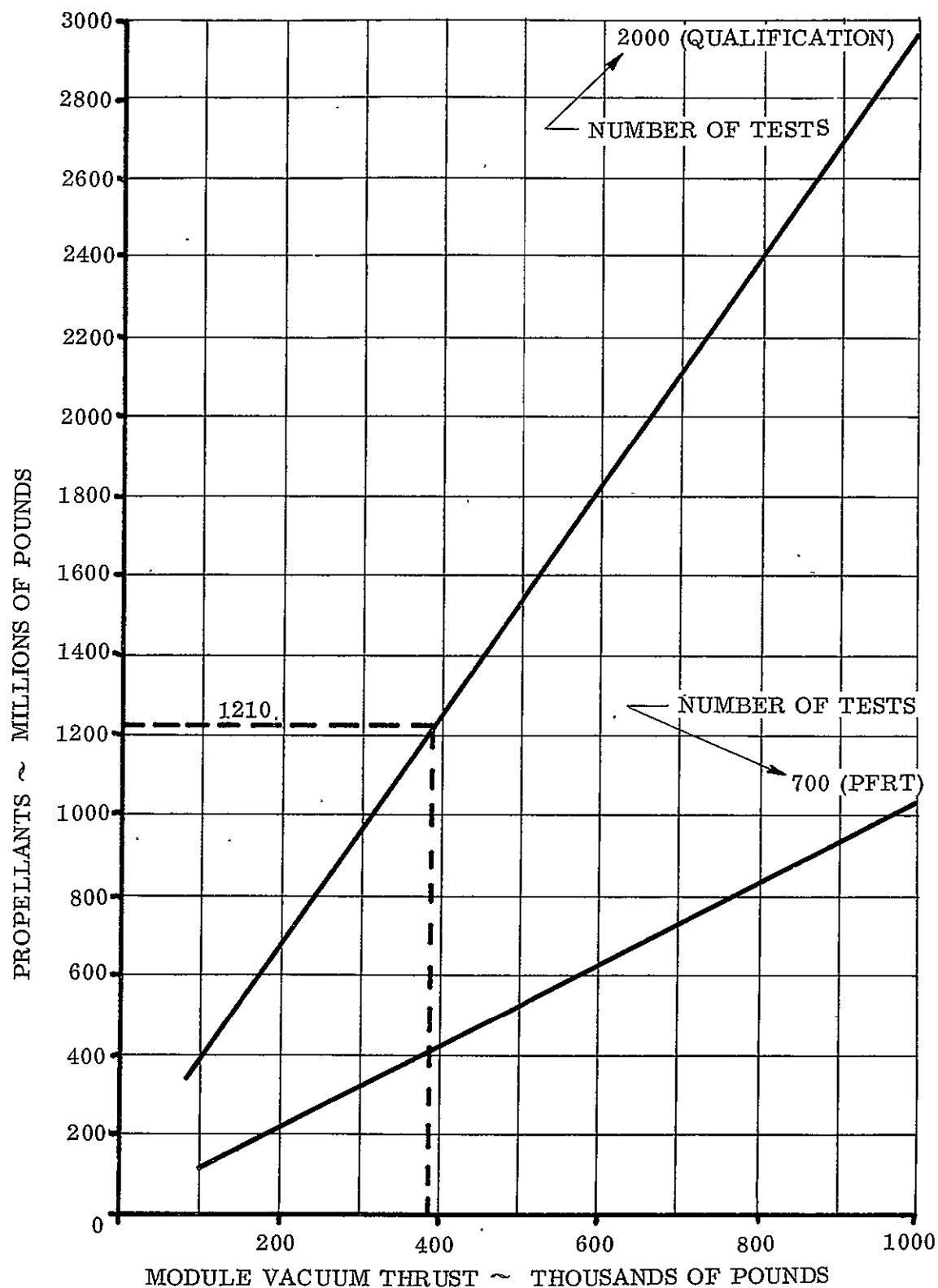


FIGURE 4.1.6.1-3 MLLV MAIN STAGE PROPULSION SYSTEM - ESTIMATED PROPELLANT CONSUMPTION DURING ENGINE DEVELOPMENT INCLUDING ANCILLIARY FLUIDS.OXYGEN/HYDROGEN MIXTURE RATIO, 6:1 (PRATT & WHITNEY DATA)

TABLE 4.1.6.1-I

MLLV COST SUMMARY(MULTICHAMBER) SINGLE STAGE ENGINES

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				100,800							100,800
LAB TECHNICIANS											
TOOLING				8,100							8,100
PRODUCTION				119,800							119,800
MANUFACTURING TEST				38,000							38,000
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				266,700							266,700
MATERIAL									*58771		58,771
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL									58771		58,771
TOTAL OTHER											
TOTAL COST				266,700					58,771		325,471

* PROPELLANTS

MLLV
SINGLE STAGE ENGINE
MULTI-CHAMBER
PLUG ENGINE

TABLE 4:1.6.1-II

"B" - COSTS

	<u>Component</u>	<u>Engine</u>	<u>PFRT</u>	<u>Qual.</u>	<u>Total</u>
Engineering	\$31.0M	\$ 48.2M	\$10.8M	\$10.8M	\$100.8M
Test	15.0M	17.6M	2.7M	2.7M	38.0M
Equipment	2.7M	8.1M			10.8M
Tooling (Basic)	2.7M	5.4M			8.1M
Fabrication	<u>15.0M</u>	<u>59.6M</u>	<u>17.2M</u>	<u>17.2M</u>	<u>109.0M</u>
Subtotal	\$66.4M	\$138.9M	\$30.7M	\$30.7M	\$266.7M

MLLV

PROPELLANT CONSUMPTION

INC. ANCILLARY FLUIDS

OXYGEN/HYDROGEN

MIX RATIO = 6.0

2,000 QUALIFICATION TESTS

SINGLE STAGE ENGINE PROGRAM

MULTI-CHAMBER

PLUG ENGINE

TABLE 4.1.6.1-III

<u>TOTAL CONSUMPTION</u>	1,210,000,000 lbs.
OXYGEN	1,037,142,857 lbs.
HYDROGEN	172,857,143 lbs.
<u>COST</u>	
OXYGEN \$.015 X 1,037,142,857 lbs. =	\$15,557,143
HYDROGEN \$.25 X 172,857,143 lbs. =	<u>43,214,286</u>
TOTAL	<u><u>\$58,771,429</u></u>

4.1.6.2 Toroidal/Aerospike Engine Cost - 1200 PSIA (286,000 Pound Thrust)

This paragraph presents the get ready cost for a toroidal/aerospike engine system consisting of twenty-eight 1200 psia modules, each of which will produce 286,000 pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne.

Figure 4.1.6.2-1 displays, in terms of percentages, a breakdown of the A and B categories.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 4.1.6.1-I above. The toroidal/aerospike engine costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

Table 4.1.6.2-I displays the results which include propellant costs.

TABLE 4.1.6.2-I

MLLV COST SUMMARY . SINGLE STAGE ENGINES (TOROIDAL)

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				18,800							18,800
LAB TECHNICIANS											
TOOLING				1,500							1,500
PRODUCTION				22,300							22,300
MANUFACTURING TEST				7,100							7,100
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				49,700							49,700
MATERIAL									*58771		58,771
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL									58771		58,771
TOTAL OTHER											
TOTAL COST				49,700					58,771		108,471

* PROPELLANT

MLLV
TOROIDAL ENGINE PROGRAM
286 K THRUST PER MODULE
1200 PSI

TABLE 4.1.6.2-II

(In Millions)					
	<u>Component</u>	<u>Engine</u>	<u>PFRT</u>	<u>Qual</u>	<u>Total</u>
B. Developmental Testing					
Engineering	\$ 5.8	\$ 9.0	\$2.0	\$2.0	\$18.8
Test	2.8	3.3	.5	.5	7.1
Equipment	.5	1.5			2.0
Tooling (Basic)	.5	1.0			1.5
Fabrication	<u>2.8</u>	<u>11.1</u>	<u>3.2</u>	<u>3.2</u>	<u>20.3</u>
Subtotal	\$12.4	\$25.9	\$5.7	\$5.7	\$49.7

8.0 Million Pounds Thrust - 28 Modules (6 Segments, Per Module).
J-2S Engine Turbo-machinery Unit.

4.1.6.3 Toroidal/Aerospike Engine Cost - 1200 PSIA (One Million Pound Thrust)

This paragraph presents the get ready cost for a toroidal/aerospike engine system consisting of eight 1200 psia modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne.

Figure 4.1.6.3-I displays, in terms of percentage, the breakdown of A and B costs. These percentages and the results are displayed in Table 4.1.6.3-I. Propellant costs are also included.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 4.1.6.1-I above. The toroidal/aerospike engine costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

	Get Ready or "A" Percentages		Development or "B" Percentages			
			Component	Engine	PFRT	Qual.
Design and Development						
Engineering	68.2%		28.3%	26.7%	25.5%	25.5%
Test	-0-		11.4	6.7	6.4	6.4
Equipment	4.5		12.5	20.3	-0-	-0-
Tooling (Basic)	27.3		5.2	1.8	-0-	-0-
Fabrication	-0-		39.5	44.5	68.1	68.1
Subtotal	100%	51.1%	100%	34.5%	100%	8.5%
Production (Non-Recurring)						
Tooling (Basic)	38.1%					
Equipment	23.8					
GSE	38.1					
Subtotal	100%	48.9%				
		16.3%				
Total				83.7%		
			100%			

NOTE: Percentages based on 1200 psia, one million pound thrust module, as submitted by Rocketdyne, in memo No. 68RC-16347 dated December 20, 1968.

This percentage was:

- (1) Used as is for the 1200 psia, one million pound module and for the 2000 psia, one million pound module.

FIGURE 4.1.6.3-1 DEVELOPMENT COSTS FOR 1200 AND 2000 PSIA TOROIDAL/AEROSPIKE PROPULSION SYSTEM DIVIDED INTO PERCENTAGES OF GET READY AND DEVELOPMENT TEST COSTS-BASED ON 1200 PSIA - ONE MILLION POUND THRUST MODULE

TABLE 4.1.6.3-I

SINGLE STAGE ENGINES
(TOROIDAL)

MLLV COST SUMMARY

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				30,300							30,300
LAB TECHNICIANS											
TOOLING				3,000							3,000
PRODUCTION				67,500							67,500
MANUFACTURING TEST				10,100							10,100
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				110,900							110,900
MATERIAL									*58771		58,771
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL									58771		58,771
TOTAL OTHER											
TOTAL COST				110,900					58,771		169,671

* PROPELLANT

MLLV
TOROIDAL ENGINE PROGRAM
1m K THRUST PER MODULE 1200 PSI

TABLE 4.1.6.3-II

	<u>Component</u>	(In Millions)			<u>Total</u>
		<u>Engine</u>	<u>PFRT</u>	<u>Qual</u>	
B. Developmental Testing					
Engineering	\$11.0	\$14.3	\$2.5	\$2.5	\$ 30.3
Test	5.3	3.6	.6	.6	10.1
Equipment	4.8	10.8			15.6
Tooling (Basic)	2.0	1.0			3.0
Fabrication	15.1	24.0	6.4	6.4	51.9
Subtotal	\$38.2	\$53.7	\$9.5	\$9.5	\$110.9

8.0 Million Pounds Thrust - 8 Modules (20 Segments/module; 1 million/module). New Turbo-machinery unit.

4.1.6.4 Toroidal/Aerospike Engine Cost - 2000 PSIA (One Million Pound Thrust)

This paragraph presents the get ready cost for a toroidal/aerospike engine system consisting of eight 2000 psia modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine system were supplied by Rocketdyne. However, the costs for the "A" and "B" categories were combined together.

In order to determine that amount which applied to "B" costs only, the same percentage apportionment between A and B costs used for the 1200 psia one million modules was applied to the 2000 psia one million propulsion system. Figure 4.1.6.3-1 displays, in terms of percentages, this breakdown of the categories. These percentages were then applied to the 2000 psia module data and the results are displayed in Table 4.1.6.4-I. Propellant costs are also included.

NOTE: The costs for this engine configuration are not added in the cost summary for the single stage vehicle as shown in Table 4.1.6.1-I above. The toroidal/aerospike cost must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

TABLE 4.1.6.4-I

MLLV COST SUMMARY SINGLE STAGE ENGINES (TOROIDAL)

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				37,300							37,300
LAB TECHNICIANS											
TOOLING				3,900							3,900
PRODUCTION				83,800							83,800
MANUFACTURING TEST				11,500							11,500
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				136,500							136,500
MATERIAL									*58771		58,771
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL									58771		58,771
TOTAL OTHER											
TOTAL COST				136,500					58,771		195,271

* PROPELLANT

MLLV
TOROIDAL ENGINE PROGRAM
1M THRUST PER MODULE
2000 PSI

TABLE 4.1.6.4-II

"B" COSTS					
(DOLLARS IN MILLIONS)					
	COMPONENT	ENGINE	PFRT	QUAL.	TOTAL
Engineering	13.6	17.7	3.0	3.0	37.3
Test	5.7	4.4	.7	.7	11.5
Equipment	6.2	13.4			19.6
Tooling (Basic)	2.7	1.2			3.9
Fabrication	<u>18.9</u>	<u>29.5</u>	<u>7.9</u>	<u>7.9</u>	<u>64.2</u>
Subtotal (Incl. Fee)	47.1	66.2	11.6	11.6	136.5

(A & B = \$161.6M)

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4.1.7 Facility Checkout Vehicle - Single Stage Vehicle

The facility vehicle is defined as the test article that will be used to checkout the following:

- a. The manufacturing tools, facilities and equipment
- b. All R&D test facilities and equipment
- c. Handling and transportation equipment
- d. Launch complex facilities and support areas
- e. All GSE (manufacturing facility and launch facility)
- f. All processes and procedures

The primary objective of the facility vehicle is to achieve a state of operational readiness prior to processing of the flight vehicles. The costs associated with this facility vehicle are displayed in Table 4.1.7.0-I. The facility vehicle consists of the following types of cost elements.

- a. Single stage structure
- b. Systems
- c. Transportation from the manufacturing plant to the launch site
- d. The cost of a dummy payload and instrument unit
- e. Launch cycle cost (based on one years cost to checkout the facility)
- f. Propellant cost
- g. Launch site maintenance cost

TABLE 4.1.7.0-I

MLLV COST SUMMARY

FACILITY VEHICLE SINGE STAGE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									287,536		287,536
TOTAL COST									287,536		287,536

MLLV
NON-RECURRING
R&D COST
FACILITY VEHICLE - S/S
TABLE 4.1.7.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Structures	23,464
Systems	16,779
Transportation	84
Dummy Payload & IU	750
Launch Operations	225,672
Propellant	3,287
Launch Manintenance (1 YR)	<u>17,500</u>
Total Cost	<u><u>287,536</u></u>

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4.1.8 Manufacturing Mockup Vehicle - Single Stage Vehicle

The manufacturing mockup will be used extensively to aid and assist in the development of the production tooling and the manufacturing techniques.

This mockup is not a complete vehicle, but is limited to full size sub-assemblies and sub-systems. The costs for developing the mockup for the single stage vehicle are reflected in Table 4.1.8.0-I.

TABLE 4.1.8.0-I
MLLV COST SUMMARY

MANUFACTURING MOCKUP - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	30								3	30
PROGRAM PLAN. & REPT.	6	75								6	75
INDUSTRIAL RELATIONS	1	14								1	14
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION			168	1,634						168	1,634
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			45	436						45	436
FACILITIES											
DIRECT DIST			54	523						54	523
TRAINING			2	24						2	24
TOTAL DIRECT LABOR	10	119	269	2,617						279	2,736
MATERIAL				330							330
LOGISTIC HARDWARE											
BURDEN				110							110
TOTAL MATERIAL				440							440
TOTAL OTHER											
TOTAL COST		119		3,057							3,176

MLLV

PART I

MANUFACTURING MOCK-UP - S/S

ASSEMBLY OR SYSTEM

TABLE 4.1.8.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	168,149		
Tooling			
Manufacturing Test			
Q&RA			
Facilities	44,880		
Manufacturing Technician			
Total Direct Labor	<u>213,029</u>		
Program Executive		2,556	30,186
Program Planning & Reporting		6,391	75,478
Industrial Relations		<u>1,385</u>	<u>13,462</u>
Total Labor - Part I		<u>10,332</u>	<u>119,126</u>
<u>Material</u>			
Program Planning & Reporting			128
Industrial Relations			<u>139</u>
Material Subtotal			267
Material & Administrative Burden			<u>91</u>
Total Material			<u>358</u>
TOTAL COST - PART I			<u>119,484</u>

TABLE 4.1.8.0-III

MLLV PART II COST SUMMARY

MANUFACTURING MOCK-UP - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING										
PRODUCTION			168	1,634					168	1,634
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			45	436					45	436
DIRECT DIST			54	523					54	523
TRAINING			2	24					2	24
TOTAL DIRECT LABOR			269	2,617					269	2,617
MATERIAL				317						317
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				13						13
SUBTOTAL				330						330
MAT. & ADM. BURDEN				110						110
TOTAL MATERIAL				440						440
TOTAL PART II COST				3,057						3,057

MLLV
DEVELOPMENTAL COST
NON-RECURRING
MANUFACTURING MOCK-UP - S/S

TABLE 4.1.8.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u> (In Thousands)
Fab. & Assembly	168,149	1,634
Direct Distributable	<u>53,808</u>	<u>523</u>
Subtotal	221,957	2,157
Training	<u>2,442</u>	<u>24</u>
Subtotal	224,399	2,181
Q&RA	<u>44,880</u>	<u>436</u>
TOTAL LABOR	269,279	2,617
<u>Material</u>		
Raw Material		317
Q&RA		<u>13</u>
Material Subtotal		330
Material & Admin.Burden		<u>110</u>
TOTAL MATERIAL		<u>440</u>
TOTAL MANUFACTURING COST		<u><u>3,057</u></u>

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4.1.9 Systems Development Facility (Breadboard) - Single Stage Vehicle

The Systems Development Breadboard Facility will provide for extensive testing, evaluation, and verification of components, subsystems, and systems under controlled conditions that approximate those at the launch site.

Existing facilities at Michoud will be used to house the breadboard. The equipment for these tests will primarily consist of the elements of vehicle and GSE hardware and/or simulators that make up the breadboard plus the computer complex.

The costs associated with the SDF for the single stage vehicle are displayed in Table 4.1.9.0-I.

TABLE 4.1.9.0-I

MLLV COST SUMMARY

SDF - S/S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									73,200		73,200
TOTAL COST									73,200		73,200

MLLV
NON-RECURRING COST
R&D TEST FACILITIES
SYSTEMS DEVELOPMENT FACILITY - S/S

TABLE 4.1.9.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Equipment	56,000
Operation	<u>17,200</u>
Total Cost	<u><u>73,200</u></u>

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4.1.10 R&D Flight Vehicles - Single Stage Vehicle

The two R&D flight vehicles are the final qualification testing that must precede the manned flights in order to qualify the system.

The prime objectives of flight tests are:

- a. Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground testing.
- b. Acquisition of flight data and correlation of these data with the results of ground tests.
- c. Flight verification of the launch vehicle and ground support equipment prior to manned flight.
- d. Flight verification of stage subsystems affecting crew safety prior to manned flight.
- e. Ground crew training.

Each flight space vehicle will be as complete as practicable; i. e., no dummy stage, modules or subsystems, with the exception of a simulated payload.

Individual stage (specimen) costs were obtained from the "C" category estimates with allowances for the additional R&D instrumentation.

The costs for two single stage vehicles are shown in Table 4.1.0.0-I. This cost includes all the cost of stage hardware, R&D instrumentation, instrument unit, SE&I and launch cycle costs (these launch costs for each R&D flight are based on a nine month cycle; the normal launch cycle, will however, be based on six months). In addition, these costs include all transportation, facility and equipment maintenance.

TWO R&D FLIGHTS - SINGLE STAGE

TABLE 4.1.10.0-I
MLLV COST SUMMARYA ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									731,826		731,826
TOTAL COST									731,826		731,826

TABLE 4.1.10.0-II
MLLV

DEVELOPMENTAL COSTS

TWO R&D FLIGHTS - SINGLE STAGE

(DOLLARS IN THOUSANDS)

<u>Element of Cost</u>	<u>No. 1</u>	<u>No. 2</u>
Stage Hardware (1)	\$146,216	\$133,186
Propellants	3,387	3,287
Instrument Unit	9,346	9,346
SDF Operations	6,169	6,169
Launch Operations	165,856	165,856
Launch Maint	8,750	8,750
SE&I	8,480	8,480
Instrumentation	24,324	24,324
	<hr/>	<hr/>
	\$372,428	\$359,398
 TOTAL COSTS OF TWO R&D FLIGHTS	 	 \$731,826

(1) Includes Transportation and Facility and Equipment Maintenance Costs

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4.1.11 Wind Tunnel (Model Tests) - Single Stage Vehicle

Models will be used in wind tunnel tests to investigate the aerodynamic characteristics and dynamic behavior of the MLLV single stage under laboratory conditions.

Test Description

Force Model Tests - The purpose of these tests will be to ascertain range safety aerodynamics after inflight destruct, by checking the aerodynamic characteristics of models of selected fragments of the single stage.

MLLV Single Stage Base Heating Model Tests - Supersonic and transonic tests will be conducted. The tests will include heating and pressure measurements in the base region for the range of possible configurations and anticipated flight environments.

Performance Characteristics of Various Vehicle Combinations - Model tests will determine aerodynamic performance characteristics of possible vehicle configurations within the vehicle family.

Resource Requirements

The assumption is that adequate facilities already exist for the conduct of the model tests to develop the required information for the MLLV program. It is anticipated, therefore, that costs for these tests will be based on procurement of the models and occupancy time at the test facility.

Based on prior test experience, the following estimates were made as shown in Table 4.1.11.0-I.

TABLE 4.1.11.0-I

MLLV COST SUMMARY

WIND TUNNEL

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									600		600
TOTAL COST									600		600

MLLV
DEVELOPMENTAL TESTING COSTS
NON-RECURRING
WIND TUNNEL TEST

TABLE 4.1.11.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Single Stage	<u>600</u>

These Costs based on Engineering Estimate.

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4.2 INJECTION STAGE - ENGINE MODULE

The summary costs for testing of the injection stage - engine module are displayed in Table 4.2.0.0-I. The costs include not only the cost associated with conducting the tests but also the costs of the test specimens. Specimen costs were developed from the recurring costs contained in Book C of this volume. Figure 4.2.0.0-I displays the total costs associated with the injection stage - engine module and the appropriate subparagraph where the cost information is located.

TABLE 4.2.0.0-I

MLLV COST SUMMARY

ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	9	83								9	84
PROGRAM PLAN. & REPT.	18	208								18	208
INDUSTRIAL RELATIONS	3	38								3	38
ENGINEERING			132	54,952						132	54,952
LAB TECHNICIANS			104	1,015						104	1,015
TOOLING				4,300							4,300
PRODUCTION			277	66,391						277	66,391
MANUFACTURING TEST				20,100							20,100
MANUFACTURING TECH.											
Q & R A			74	727						74	727
FACILITIES											
DIRECT DIST			121	1,186						121	1,186
TRAINING			8	64						8	64
TOTAL DIRECT LABOR	30	330	716	148,725						746	149,055
MATERIAL		1		557							558
LOGISTIC HARDWARE				16,546							16,546
BURDEN				191							191
TOTAL MATERIAL		1		17,294							17,295
TOTAL OTHER					850				140,903		141,753
TOTAL COST		331		166,019	850				140,903		308,103

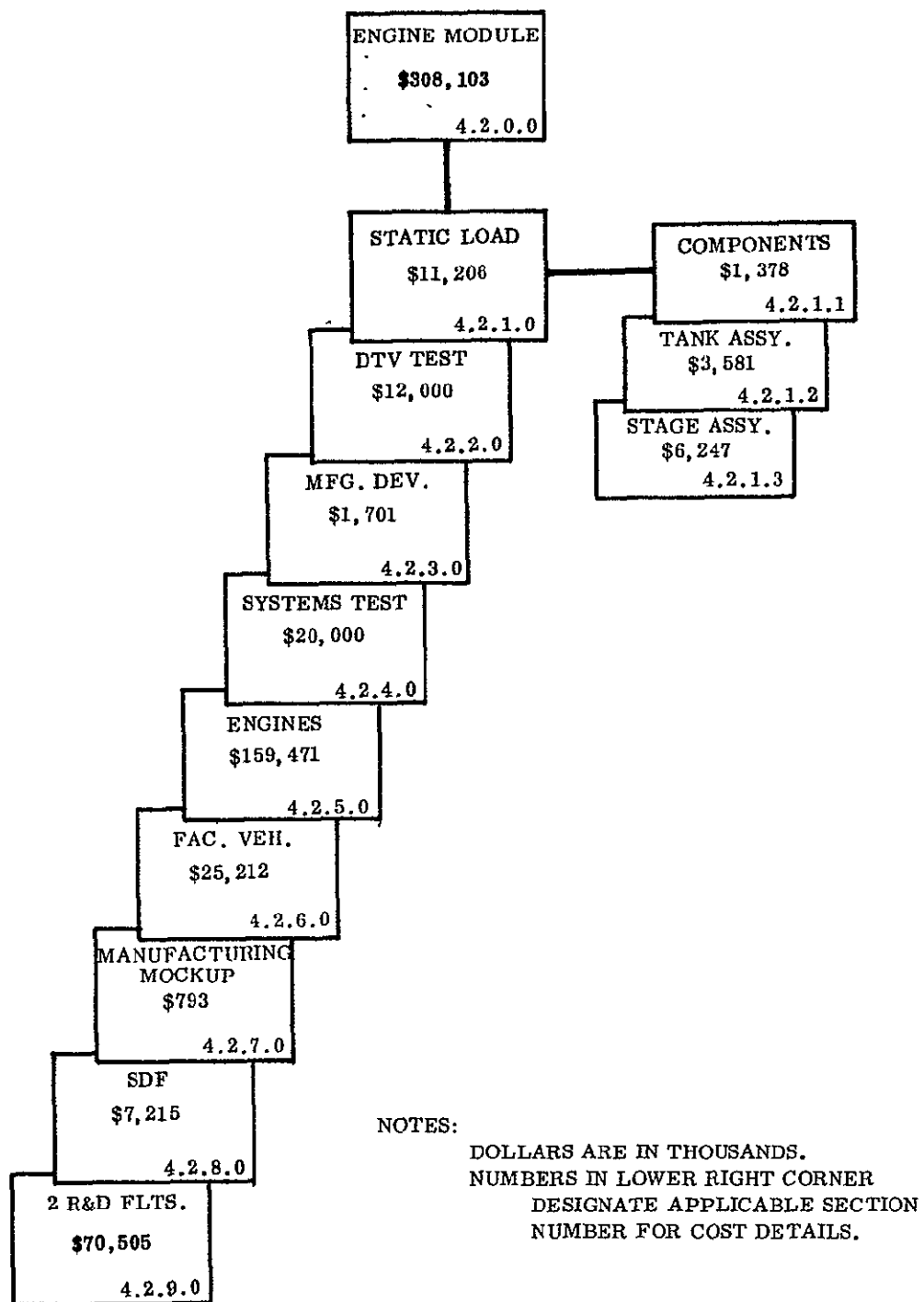


FIGURE 4.2.0.0-1 MLLV INJECTION STAGE ENGINE MODULE COST DEVELOPMENT
TEST, "B" COSTS

4.2.1 Static Load Test - Injection Stage, Engine Module

The total cost of conducting all of the static load tests for the injection stage - engine module are displayed in Table 4.2.1.0-I. In addition, Figure 4.2.1.0-1 displays the cost and subparagraph number at the various components that require static testing. Paragraph 4.2.1.1 through 4.2.1.3 reflect the cost for the tank assembly, stage assembly and other components; which include the necessary material and labor to accomplish the following functions:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture fabrication
4. Load fixture installation
5. Plumbing installation
6. Instrumentation installation
7. Mechanical checkout
8. Electrical checkout
9. Conduct the test
10. Teardown effort

4.2.1 (Continued)

c. Material and Parts

1. Raw material
2. Mechanical components
3. Electrical transducers
4. Electrical components and equipment
5. Test specimen (from "C" cost)

d. Retest Costs

Parts, materials and labor costs

The test facilities that are to be utilized for the single stage vehicle were considered adequate to accommodate the engine module; therefore, no additional facility or equipment costs were added for testing of the engine module..

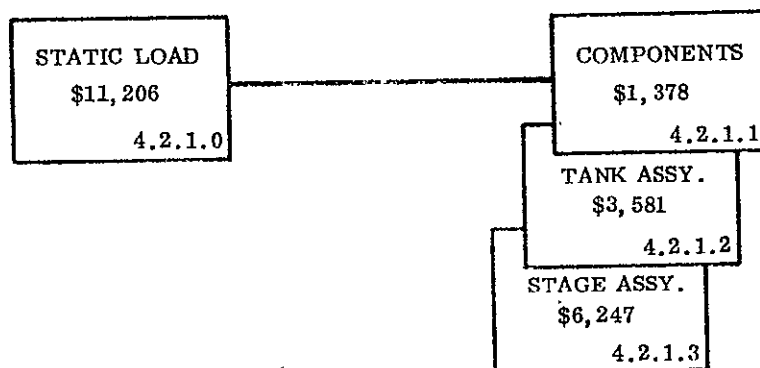
TABLE 4.2.1.0-I

MLLV COST SUMMARY - STATIC LOAD TEST - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	26								3	26
PROGRAM PLAN. & REPT.	5	64								5	64
INDUSTRIAL RELATIONS	1	12								1	12
ENGINEERING			61	719						61	719
LAB TECHNICIANS											
TOOLING											
PRODUCTION			115	1,119						115	1,119
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			5	56						5	56
FACILITIES											
DIRECT DIST			37	358						37	358
TRAINING			3	26						3	26
TOTAL DIRECT LABOR	9	102	221	2,268						230	2,370
MATERIAL				127							127
LOGISTIC HARDWARE				8,665							8,665
BURDEN				44							44
TOTAL MATERIAL				8,836							8,836
TOTAL OTHER											
TOTAL COST		102		11,104							11,206



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 4.2.1.0-1 MLLV INJECTION STAGE ENGINE MODULE STATIC LOAD COSTS
 DEVELOPMENT TEST, "B" COSTS

4.2.1.1 Component Testing – Static Load Test

TABLE 4.2.1.1-I
MLLV COST SUMMARY

COMPONENTS - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	6								1	6
PROGRAM PLAN. & REPT.	1	15								1	15
INDUSTRIAL RELATIONS		3									3
ENGINEERING			14	168						14	168
LAB TECHNICIANS											
TOOLING											
PRODUCTION			27	260						27	260
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	13						1	13
FACILITIES											
DIRECT DIST			9	83						9	83
TRAINING			1	13						1	13
TOTAL DIRECT LABOR	2	24	52	527						54	551
MATERIAL				29							29
LOGISTIC HARDWARE				788							788
BURDEN				10							10
TOTAL MATERIAL				827							827
TOTAL OTHER											
TOTAL COST		24		1,354							1,378

MLLV
NON-RECURRING

PART I

STATIC LOAD TEST - COMPONENTS - E/M
ASSEMBLY OR SYSTEM

TABLE 4.2.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>14,121</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>26,410</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>1,335</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>41,866</u>		
Program Executive		<u>503</u>	<u>\$ 5,940</u>
Program Planning & Reporting		<u>1,256</u>	<u>14,833</u>
Industrial Relations		<u>272</u>	<u>2,644</u>
Total Labor - Part I		<u>2,031</u>	<u>\$23,417</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 25</u>
Industrial Relations			<u>27</u>
Material Subtotal			<u>53</u>
Material & Administrative Burden			<u>18</u>
Total Material			<u>\$ 71</u>
TOTAL COST - PART I			<u>\$23,488</u>

TABLE 4.2.1.1-III

MLLV PART II COST SUMMARY

COMPONENTS - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	14	168							14	168
LAB TECHNICIANS										
TOOLING										
PRODUCTION							27	260	27	260
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							1	13	1	13
DIRECT DIST							9	83	9	83
TRAINING							1	13	1	13
TOTAL DIRECT LABOR	14	168					38	359	52	527
MATERIAL				*788						788
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								29		29
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				788				29		817
MAT. & ADM. EXPENSE								10		10
TOTAL MATERIAL				788				39		827
TOTAL PART II COST		168		788				398		1,354

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

COMPONENTS - E/M
CONDUCT STATIC LOAD TEST
TABLE 4.2.1.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	12,420	\$147
Retest Allowance	<u>1,704</u>	<u>21</u>
TOTAL COST	<u><u>14,121</u></u>	<u><u>\$168</u></u>

MLIV
R & D TEST COST
NON-RECURRING

COMPONENTS - E/M
CONDUCT STATIC LOAD TEST

TABLE 4.2.1.1-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	21,750	\$211
(2) Retest Allowance	4,960	49
Subtotal "A"	26,710	\$260
(3) Direct Distributable	8,547	83
Subtotal "B"	35,257	\$346
(4) Training	1,335	13
Subtotal "C"	35,645	\$346
(5) Q&RA	1,335	13
TOTAL LABOR	36,980	\$359
<u>Material</u>		
(6) Raw Material & Parts		\$ 29
(7) Q&RA		
Material Subtotal		\$ 29
(8) Material & Admin. Burden		10
TOTAL MATERIAL		\$ 39
TOTAL COST		\$398

4.2.1.2 Tank Assembly - Static Load Test

TABLE 4.2.1.2-I

MLLV COST SUMMARY

TANK ASSEMBLY - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	5								1	5
PROGRAM PLAN. & REPT.	1	11								1	11
INDUSTRIAL RELATIONS		2									2
ENGINEERING			11	127						11	127
LAB TECHNICIANS											
TOOLING											
PRODUCTION			20	197						20	197
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	10						1	10
FACILITIES											
DIRECT DIST			6	63						6	63
TRAINING			1	3						1	3
TOTAL DIRECT LABOR	2	18	39	400						41	418
MATERIAL				23							23
LOGISTIC HARDWARE				3,132							3,132
BURDEN				8							8
TOTAL MATERIAL				3,163							3,163
TOTAL OTHER											
TOTAL COST		18		3,563							3,581

MLLV
NON-RECURRING

PART I

TANK ASSEMBLY - E/M

ASSEMBLY OR SYSTEM

STATIC LOAD TEST

TABLE 4.2.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>10,725</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>20,250</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>1,012</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>31,987</u>		
Program Executive		<u>384</u>	<u>\$ 4,535</u>
Program Planning & Reporting		<u>960</u>	<u>11,338</u>
Industrial Relations		<u>208</u>	<u>2,022</u>
Total Labor - Part I		<u>1,552</u>	<u>\$17,895</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 19</u>
Industrial Relations			<u>21</u>
Material Subtotal			<u>\$ 40</u>
Material & Administrative Burden			<u>14</u>
Total Material			<u>\$ 54</u>
TOTAL COST - PART I			<u>\$17,949</u>

TABLE 4.2.1.2-III

MLLV PART II COST SUMMARY

TANK ASSEMBLY - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	11	127							11	127
LAB TECHNICIANS										
TOOLING										
PRODUCTION							20	197	20	197
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							1	10	1	10
DIRECT DIST							6	63	6	63
TRAINING							1	3	1	3
TOTAL DIRECT LABOR	11	127					28	273	39	400
MATERIAL				*3,132						3,132
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								23		23
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				*3,132				23		3,163
MAT. & ADM. BURDEN								8		
TOTAL MATERIAL				*3,132				31		3,163
TOTAL PART II COST		127		*3,132				304		3,563

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

TANK ASSEMBLY - E/M
CONDUCT STATIC LOAD TEST

TABLE 4.2.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	9,419	\$112
Retest Allowance	<u>1,306</u>	<u>15</u>
TOTAL COST	<u>10,725</u>	<u>\$127</u>

MLLV
R & D TEST COST
NON-RECURRING

TANK ASSEMBLY - E/M
CONDUCT STATIC LOAD TEST

TABLE 4.2.1.2-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	16,448	\$160
(2) Retest Allowance	3,802	37
Subtotal "A"	20,250	\$197
(3) Direct Distributable	6,480	63
Subtotal "B"	26,730	\$260
(4) Training	294	3
Subtotal "C"	27,024	\$263
(5) Q&RA	1,012	10
TOTAL LABOR	28,036	\$273
<u>Material</u>		
(6) Raw Material & Parts		\$ 23
(7) Q&RA		
Material Subtotal		\$ 23
(8) Material & Admin. Burden		8
TOTAL MATERIAL		\$ 31
TOTAL COST		\$304

4.2.1.3 Stage Assembly - Static Load Test

TABLE 4.2.1.3-I

MLLV COST SUMMARY

STAGE ASSEMBLY - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	15								1	15
PROGRAM PLAN. & REPT.	3	38								3	38
INDUSTRIAL RELATIONS	1	7								1	7
ENGINEERING			36	424						36	424
LAB TECHNICIANS											
TOOLING											
PRODUCTION			68	662						68	662
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			3	33						3	33
FACILITIES											
DIRECT DIST			22	212						22	212
TRAINING			1	10						1	10
TOTAL DIRECT LABOR	5	60	130	1,341						135	1,401
MATERIAL				74							74
LOGISTIC HARDWARE				4,745							4,745
BURDEN				26							26
TOTAL MATERIAL				4,846							4,846
TOTAL OTHER											
TOTAL COST		60		6,187							6,247

MLLV
NON-RECURRING

PART I

STATIC LOAD TEST - STAGE ASSEMBLY - E/M
ASSEMBLY OR SYSTEM

1ST UNIT COST
TABLE 4.2.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	<u>35,944</u>		
Logistics	<u> </u>		
Laboratory Technician	<u> </u>		
Production	<u>68,136</u>		
Tooling	<u> </u>		
Manufacturing Test	<u> </u>		
Q&RA	<u>3,407</u>		
Facilities	<u> </u>		
Manufacturing Technician	<u> </u>		
Total Direct Labor	<u>107,487</u>		
Program Executive		<u>1,290</u>	<u>\$15,235</u>
Program Planning & Reporting		<u>3,225</u>	<u>38,087</u>
Industrial Relations		<u>699</u>	<u>6,794</u>
Total Labor - Part I		<u>\$5,214</u>	<u>\$60,116</u>
<u>Material</u>			
Program Planning & Reporting			<u>\$ 64</u>
Industrial Relations			<u>70</u>
Material Subtotal			<u>134</u>
Material & Administrative Burden			<u>46</u>
Total Material			<u>\$ 180</u>
TOTAL COST - PART I			<u>\$60,296</u>

TABLE 4.2.1.3-III

MLLV PART II COST SUMMARY

STAGE ASSEMBLY - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	36	424							36	424
LAB TECHNICIANS										
TOOLING										
PRODUCTION							68	662	68	662
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							3	33	3	33
DIRECT DIST							22	212	22	212
TRAINING							1	10	1	10
TOTAL DIRECT LABOR	36	424					94	917	130	1,341
MATERIAL				*4,745						4,745
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								74		74
MFG. TECHNICIANS										
Q & R A								1		1
SUBTOTAL				4,745				75		4,820
MAT. & ADM. BURDEN								26		26
TOTAL MATERIAL				4,745				101		4,846
TOTAL PART II COST		424		4,745				1,018		6,187

* Speciment

MLLV
R & D TEST COST
NON-RECURRING

STAGE ASSEMBLY - E/M
CONDUCT STATIC LOAD TEST
TABLE 4.2.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
Engineering	31,620	\$373
Retest Allowance	<u>4,324</u>	<u>51</u>
TOTAL COST	<u><u>35,944</u></u>	<u><u>\$424</u></u>

MLLV
R & D TEST COST
NON-RECURRING

STAGE ASSEMBLY - E/M
CONDUCT STATIC LOAD TEST

TABLE 4.2.1.3-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	55,563	\$540
(2) Retest Allowance	12,573	122
Subtotal "A"	68,136	\$662
(3) Direct Distributable	21,804	212
Subtotal "B"	89,940	\$874
(4) Training	989	10
Subtotal "C"	90,929	\$884
(5) Q&RA	3,407	33
TOTAL LABOR	94,336	\$917
<u>Material</u>		
(6) Raw Material & Parts		\$ 74
(7) Q&RA		1
Material Subtotal		\$ 75
(8) Material & Admin. Burden		26
TOTAL MATERIAL		\$101
TOTAL COST		\$1,018

4.2.2 Dynamic Testing - Injection Stage - Engine Module

The total cost for performing the dynamic tests on the injection stage - engine module are displayed in Table 4.2.2.0-I, these costs include the labor and material to accomplish the following functions:

a. Engineering

1. Mechanical and Electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility C/O and preparation
2. Specimen installation
3. Load fixture - fabrication and installation
4. Plumbing installation
5. Instrumentation installation
6. Mechanical checkout
7. Electrical checkout
8. Conduct the test
9. Teardown effort

c. Material and Parts

1. Raw materials
2. Mechanical components
3. Electrical transducers

4.2.2 (Continued)

4. Electrical components and equipment

5. Test specimen (from "C" costs)

d. Retest

Parts, materials and labor costs

The test facilities and necessary equipment to conduct dynamic testing of the injection stage - engine module also are displayed in Table 4.2.2.0-I. These costs are additive to the dynamic test facility cost of the single stage vehicle as that vehicle carries the majority of the costs associated with dynamic testing.

TABLE 4.2.2.0-I

MLLV COST SUMMARY DYNAMIC TEST - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	31								3	31
PROGRAM PLAN. & REPT.	7	78								7	78
INDUSTRIAL RELATIONS	1	14								1	14
ENGINEERING			71	833						71	833
LAB TECHNICIANS											
TOOLING											
PRODUCTION			120	1,164						120	1,164
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			30	291						30	291
FACILITIES											
DIRECT DIST			38	372						38	372
TRAINING			2	17						2	17
TOTAL DIRECT LABOR	11	123	261	2,677						272	2,800
MATERIAL		1		349							350
LOGISTIC HARDWARE				7,881							7,881
BURDEN				119							119
TOTAL MATERIAL		1		8,349							9,200
TOTAL OTHER						850					850
TOTAL COST		124		11,026		850					12,000

MLLV

PART I

DYNAMIC TEST - E/M

ASSEMBLY OR SYSTEM

TABLE 4.2.2.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	70,520		
Logistics			
Laboratory Technician			
Production	119,745		
Tooling			
Manufacturing Test			
Q&RA	29,936		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>220,201</u>		
Program Executive		2,642	31,206
Program Planning & Reporting		6,606	78,016
Industrial Relations		1,431	13,912
Total Labor - Part I		<u>10,679</u>	<u>123,135</u>
<u>Material</u>			
Program Planning & Reporting			132
Industrial Relations			143
Material Subtotal			<u>275</u>
Material & Administrative Burden			94
Total Material			<u>368</u>
TOTAL COST - PART I			<u>123,504</u>

CONDUCT DYNAMIC TEST - E/M

TABLE 4.2.2.0-III

MLLV PART II COST SUMMARY

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	71	833							71	833
LAB TECHNICIANS										
TOOLING										
PRODUCTION							120	1,164	120	1,164
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							30	291	30	291
DIRECT DIST							38	372	38	372
TRAINING							2	17	2	17
TOTAL DIRECT LABOR	71	833					190	1,844	261	2,677
MATERIAL				* 7,881						7,881
LAB. TECHNICIANS										
TOOLING										
PRODUCTION								340		340
MFG. TECHNICIANS										
Q & R A								9		9
SUBTOTAL				7,881				349		8,230
MAT. & ADM. BURDEN								119		119
TOTAL MATERIAL				7,881				468		8,349
TOTAL PART II COST		833		7,881				2,312		11,026

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

INJECTION STAGE - E/M
CONDUCT DYNAMIC TEST

TABLE 4.2.2.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
Engineering	61,352	725
Retest Allowance	<u>9,168</u>	<u>108</u>
TOTAL COST	<u><u>70,520</u></u>	<u><u>833</u></u>

MLLV
R & D TEST COST
NON-RECURRING

INJECTION STAGE - E/M
CONDUCT DYNAMIC TEST

TABLE 4.2.2.0-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	100,286	975
(2) Retest Allowance	<u>19,459</u>	<u>189</u>
Subtotal	119,745	1,164
(3) Direct Distributable	<u>38,318</u>	<u>372</u>
Subtotal	158,063	1,536
(4) Training	<u>1,739</u>	<u>17</u>
Subtotal	159,802	1,553
(5) Q&RA	<u>29,936</u>	<u>291</u>
TOTAL LABOR	<u><u>189,738</u></u>	<u><u>1,844</u></u>
<u>Material</u>		
(6) Raw Material & Parts		340
(7) Q&RA		<u>9</u>
Material Subtotal		349
(8) Material & Admin. Burden		119
TOTAL MATERIAL		<u><u>468</u></u>
TOTAL COST		<u><u>2,312</u></u>

4.2.3 Manufacturing Development Test – Injection Stage – Engine Module

The manufacturing development task is directed toward the development and implementation of fabrication and assembly processes to produce the injection stage – engine module.

Defined in broad terms, the procedure is as follows:

- a. Determine manufacturing development requirements through coordination and review of engineering drawings and specifications, present methods and existing manufacturing capabilities.
- b. Establish suitable manufacturing methods. Document and coordinate these methods with applicable organizations.
- c. Define equipment requirements, tooling criteria, training requirements, and establish step-by-step procedures for critical manufacturing.
- d. Coordinate with factory, manufacturing engineering, facilities, training, etc., to assist them in the implementation and proper application of newly developed methods.

Table 4.2.3.0-I displays the cost associated with this function for the injection stage – engine module vehicle.

TABLE 4.2.3.0-1

MLLV COST SUMMARY MANUFACTURING DEVELOPMENT - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	19								2	19
PROGRAM PLAN. & REPT.	4	47								4	47
INDUSTRIAL RELATIONS	1	9								1	9
ENGINEERING											
LAB TECHNICIANS			104	1,015						104	1,015
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			28	271						28	271
FACILITIES											
DIRECT DIST			33	325						33	325
TRAINING			2	15						2	15
TOTAL DIRECT LABOR	7	75	167	1,626						174	1,701
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST		75		1,626							1,701

MLLV

PART I

MANUFACTURING DEVELOPMENT - E/M
ASSEMBLY OR SYSTEM

TABLE 4.2.3.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician	104,439		
Production			
Tooling			
Manufacturing Test			
Q&RA	27,875		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>132,314</u>		
Program Executive		1,588	18,754
Program Planning & Reporting		4,017	47,441
Industrial Relations		<u>896</u>	<u>8,709</u>
Total Labor - Part I		<u>6,501</u>	<u>74,904</u>
<u>Material</u>			
Program Planning & Reporting			80
Industrial Relations			<u>90</u>
Material Subtotal			170
Material & Administrative Burden			<u>58</u>
Total Material			<u>228</u>
TOTAL COST - PART I			<u>75,132</u>

TABLE 4.2.3.0-III

MLLV PART II COST SUMMARY MANUFACTURING DEVELOPMENT - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS							104	1,015	104	1,015
TOOLING										
PRODUCTION										
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							28	271	28	271
DIRECT DIST							33	325	33	325
TRAINING							2	15	2	15
TOTAL DIRECT LABOR							167	1,626	167	1,626
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL										
MAT. & ADM. BURDEN										
TOTAL MATERIAL										
TOTAL PART II COST								1,626		1,626

MLIV
DEVELOPMENTAL COST
NON-RECURRING
MANUFACTURING DEVELOPMENT - E/M
INJECTION STAGE

TABLE 4.2.3.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Lab Technician	104,439	1,015
Direct Distributable	<u>33,420</u>	<u>325</u>
Subtotal	137,859	1,340
Training	<u>1,516</u>	<u>15</u>
Subtotal	139,375	1,355
Q&RA	<u>37,875</u>	<u>271</u>
Total Labor	<u><u>167,250</u></u>	<u><u>1,626</u></u>
Material		
Lab. Tech.		
Q&RA		<u> </u>
Subtotal		
Material & Admin. Burden		<u> </u>
Total Material		<u><u> </u></u>
TOTAL COST		<u><u>1,626</u></u>

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4.2.4 Systems Test - Injection Stage - Engine Module

Injection stage systems tests are identified as those tests that are required in addition to the major testing (dynamic, static load, flight, etc.) that are displayed elsewhere in this section. It was not possible to define all of the specific tests that fall within this category; however, the requirements for this general category were estimated in terms of overall program costs by applying estimated data to the overall cost of producing the injection stage - engine module flight vehicle. Historical data relative to research and development testing of components and sub-systems for other programs, prior to and inclusive of the S-IC program, were used as a basis for cost estimates for the engine module. Table 4.2.4.0-1 shows the resulting cost estimates for component and sub-system testing of this module.

Systems test include: (but are not limited to)

- a. Onboard test and checkout
- b. Qualification testing
- c. Acoustics testing, etc.

TABLE 4.2.4.0-1
MLLV COST SUMMARY

SYSTEMS TEST - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									20,000		20,000
TOTAL COST									20,000		20,000

MLLV
DEVELOPMENTAL TESTING COST
NON-RECURRING

MISCELLANEOUS TESTING - E/M

TABLE 4.2.4.0-II

<u>Element of Cost</u>	(In Thousands) <u>Dollars</u>
------------------------	----------------------------------

MISCELLANEOUS TESTS INCLUDE:

On Board Test & C/O System Development
Qualification Testing.
Acoustics Testing, Etc.

Engine Module	\$20,000
---------------	----------

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4.2.5 Injection Stage Liquid Engine PFRT and Qualification Testing

This section shows the development costs (including propellant) for the 125,000 pound thrust high pressure engine.

This engine cost was extracted from Figure 4.1.6.1-I, provided by Pratt and Whitney, in the same method as used for the main stage engine.

TABLE 4.2.5.0-I

MLLV COST SUMMARY-INJECTION STAGE ENGINES

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				53,400							53,400
LAB TECHNICIANS											
TOOLING				4,300							4,300
PRODUCTION				63,700							63,700
MANUFACTURING TEST				20,100							20,100
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				141,500							141,500
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									* 17,971		17,971
TOTAL COST				141,500					17,971		159,471

* PROPELLANT

MLLV
ONE MODULE INJECTION STAGE
*ENGINES - 2

TABLE 4.2.5.0-II

"B" COSTS

	<u>Component</u>	<u>Engine</u>	<u>PFRT</u>	<u>Qual.</u>	<u>Total</u>
Engineering	\$16.4M	\$25.6M	\$ 5.7M	\$ 5.7M	\$ 53.4M
Test	8.0M	9.3M	1.4M	1.4M	20.1M
Equipment	1.4M	4.3M			5.7M
Tooling	1.4M	2.9M			4.3M
Fabrication	<u>8.0M</u>	<u>31.6M</u>	<u>9.2M</u>	<u>9.2M</u>	<u>58.0M</u>
Subtotal	\$35.2M	\$73.7M	\$16.3M	\$16.3M	\$141.5M

* 125,000 THRUST

MLLV

PROPELLANT CONSUMPTION

INC. ANCILLARY FLUIDS

OXYGEN/HYDROGEN

MIX RATIO = 6.0

2,000 QUALIFICATION TESTS

ONE MODULE INJECTION STAGE ENGINE PROGRAM

ENGINE

125K THRUST

TABLE 4.2.5.0-III

<u>TOTAL CONSUMPTION</u>		370,000,000 lbs.
OXYGEN		317,142,858 lbs.
HYDROGEN		<u>52,857,142 lbs.</u>
<u>COST</u>		
OXYGEN	$\$.015 \times 317,142,858 \text{ lbs.}$	$= \$ 4,757,143$
HYDROGEN	$\$.25 \times 52,857,142 \text{ lbs.}$	$= \underline{13,214,286}$
TOTAL		<u><u>\$17,971,429</u></u>

4.2.6 Facility Checkout Module - Injection Stage - Engine Module

The injection stage facility checkout module is defined as the test article that will be used to check out the following:

- a. The manufacturing tools, facilities and equipment.
- b. All R&D test facilities and equipment.
- c. Handling and transportation equipment.
- d. Launch complex facilities and support area.
- e. All GSE (manufacturing facility and launch facility)
- f. All processes and procedures.

The primary objective of the facility vehicle is to achieve a state of operational readiness prior to processing of the flight modules. The costs associated with this facility checkout module are displayed in Table 4.2.6.0-I. The facility module consists of the following:

- a. Engine module structure.
- b. Systems.
- c. Transportation from the manufacturing plant to the launch site.
- d. Launch cycle cost (based on one year cost to checkout the facility).
- e. Propellant cost.

TABLE 4.2.6.0-1

MLLV COST SUMMARY

FACILITY VEHICLE - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									25,212		25,212
TOTAL COST									25,212		25,212

MLLV
NON-RECURRING
R & D COST

FACILITY VEHICLE - ENGINE MODULE

TABLE 4.2.6.0-II

<u>Element of Cost</u>	(In Thousands) <u>Dollars</u>
Structures	7,881
Systems	1,871
Transportation	39
Launch Operations	15,056
Propellant	<u>365</u>
TOTAL COST	<u><u>25,212</u></u>

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4.2.7 Manufacturing Mockup Module - Injection Stage - Engine Module

The injection stage - engine module manufacturing mockup will be used extensively to aid and assist in the development of the production tooling and the manufacturing techniques.

This mockup is not a complete vehicle, and is limited to full size sub-assemblies and sub-systems. The costs for developing the mockup for the engine module are reflected in Table 4.2.7.0-I.

TABLE 4.2.7.0-I

MLLV COST SUMMARY - FACILITY MOCK-UP - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	30								1	8
PROGRAM PLAN. & REPT.	2	19								2	19
INDUSTRIAL RELATIONS		2									3
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION			42	408						42	408
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			11	109						11	109
FACILITIES											
DIRECT DIST			13	131						13	131
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	3	30	67	654						70	684
MATERIAL				81							81
LOGISTIC HARDWARE											
BURDEN				28							28
TOTAL MATERIAL				109							109
TOTAL OTHER											
TOTAL COST		30		763							793

MLLV

PART I

FACILITY MOCK - UP - E/M
ASSEMBLY OR SYSTEM

TABLE 4.2.7.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	42,037		
Tooling			
Manufacturing Test			
Q&RA	11,220		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>53,257</u>		
Program Executive		639	7,547
Program Planning & Reporting		1,598	18,872
Industrial Relations		<u>346</u>	<u>3,363</u>
Total Labor - Part I		<u>2,580</u>	<u>29,782</u>
<u>Material</u>			
Program Planning & Reporting			31
Industrial Relations			<u>35</u>
Material Subtotal			66
Material & Administrative Burden			<u>22</u>
Total Material			<u>88</u>
TOTAL COST - PART I			<u>29,870</u>

TABLE 4.2.7.0-III

MLLV PART II COST SUMMARY FACILITY MOCK-UP - E/M

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING										
PRODUCTION										
MANUFACTURING TEST			42	408					42	408
MANUFACTURING TECH.										
Q & R A			11	109					11	109
DIRECT DIST			13	131					13	131
TRAINING			1	6					1	6
TOTAL DIRECT LABOR			67	654					67	654
MATERIAL				78						78
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				3						3
SUBTOTAL				81						81
MAT. & ADM. BURDEN				28						28
TOTAL MATERIAL				109						109
TOTAL PART II COST				763						763

MLLV

NON-RECURRING

FACILITY MOCK-UP - E/M

TABLE 4.2.7.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	(IN THOUSANDS)
		<u>Dollars</u>
(1) Fab & Assy	42,037	408
(2) Direct Distributabel	<u>13,452</u>	<u>131</u>
Subtotal (A)	55,489	539
(3) Training	<u>610</u>	<u>6</u>
Subtotal (B)	56,099	545
(4) Q&RA	<u>11,220</u>	<u>109</u>
Total Tooling Labor	<u>67,319</u>	<u>654</u>
Material		
(5) Raw Material		78
(6) Q&RA		<u>3</u>
Subtotal (C)		81
(7) Material & Adm. Burden		<u>28</u>
Total Material		<u>109</u>
Total Tooling Cost		<u>763</u>

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4.2.8 Systems Development Facility (Breadboard) - Injection Stage - Engine Module

The injection stage engine module Systems Development Breadboard Facility will provide for extensive testing, evaluation, and verification of components, sub-systems and systems under controlled conditions that approximate those at the launch site.

Existing facilities at Michoud will be used to house the breadboard. The equipment for these tests will primarily consist of the elements of vehicle and GSE hardware and/or simulators that make up the breadboard plus the computer complex.

The costs associated with the SDF for the engine module are displayed in Table 4.2.8.0-I.

TABLE 4.2.8.0-I

MLLV COST SUMMARY

SDF - ENGINE MODULE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									7,215		7,215
TOTAL COST									7,215		7,215

MLLV
NON-RECURRING COST
R & D TEST FACILITIES

SYSTEMS DEVELOPMENT FACILITY - E/M

TABLE 4.2.8.0-II

<u>Element of Cost</u>	(In Thousands) <u>Dollars</u>
Equipment	7,000
Operations (1)	<u>215</u>
Total SDF	<u>7,215</u>

(1) Operation Cost is estimated for a Five Year Period.

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4.2.9 R&D Flight Modules - Injection Stage - Engine Module

The R&D injection stage - engine module flight modules are for the final qualification testing that must precede the manned flights in order to qualify the system.

The prime objectives of flight tests are:

- a. Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground testing.
- b. Acquisition of flight data and correlation of these data with the results of ground tests.
- c. Flight certification of the launch vehicle and ground support equipment prior to manned flight.
- d. Flight verification of stage subsystems affecting crew safety prior to manned flight.
- e. Ground crew training.

Individual module (specimen) costs were obtained from the "C" category of estimates with allowances for the additional R&D instrumentation. The costs for the two R&D engine modules are shown in Table 4.2.9.0-I. These costs include all of the costs associated with the engine module hardware, additional R&D instrumentation, SE&I and Launch Cycle Costs (the launch costs for each R&D flight are based on a nine month cycle). In addition, these costs include all appropriate transportation cost, facility and equipment maintenance cost.

TWO R&D FLIGHTS - E/M

TABLE 4.2.9.0-I
MLLV COST SUMMARYA ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									70,505		70,505
TOTAL COST									70,505		50,505

TABLE 4.2.9.0-II
MLLV

DEVELOPMENTAL COSTS
NON-RECURRING

TWO R&D FLIGHTS - ENGINE MODULE
(DOLLARS IN THOUSANDS)

<u>Element of Cost</u>	<u>No. 1</u>	<u>No. 2</u>
Stage Hardware (1)	\$19,444	\$17,855
Propellants	365	365
Launch Operations	9,491	9,491
SE&I	972	-72
Instrumentation	<u>5,775</u>	<u>5,775</u>
	\$36,047	\$34,458
 TOTAL COSTS OF TWO R&D FLIGHTS	 \$70,505	

(1) Includes Transportation and Facility and Equipment
Maintenance Costs

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4.3 INJECTION STAGE - FUEL MODULE

The summary costs for testing of the injection stage - fuel module are displayed in Table 4.3.0.0-I. The costs include not only the cost associated with conducting the tests, but also the costs of the required test specimens. Specimen costs were developed from the recurring costs contained in Book C of this volume. Figure 4.3.0.0-1 displays the total costs associated with the injection stage - fuel module and the appropriate sub-paragraphs where the cost information is located.

FUEL MODULE

TABLE 4.3.0.0-I
MLLV COST SUMMARYA ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		2									2
PROGRAM PLAN.& REPT.	2	5								2	5
INDUSTRIAL RELATIONS		1									1
ENGINEERING			4	51						4	51
LAB TECHNICIANS											
TOOLING											
PRODUCTION			10	96						10	96
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	5						1	5
FACILITIES					425						425
DIRECT DIST			3	31						3	31
TRAINING				1							1
TOTAL DIRECT LABCR	2	8	28	184	425					30	617
MATERIAL				17							17
LOGISTIC HARDWARE				11786							11,876
BURDEN				6							6
TOTAL MATERIAL				11809							11,809
TOTAL OTHER									43589		43,589
TOTAL COST		8		11993	425				43589		56,015

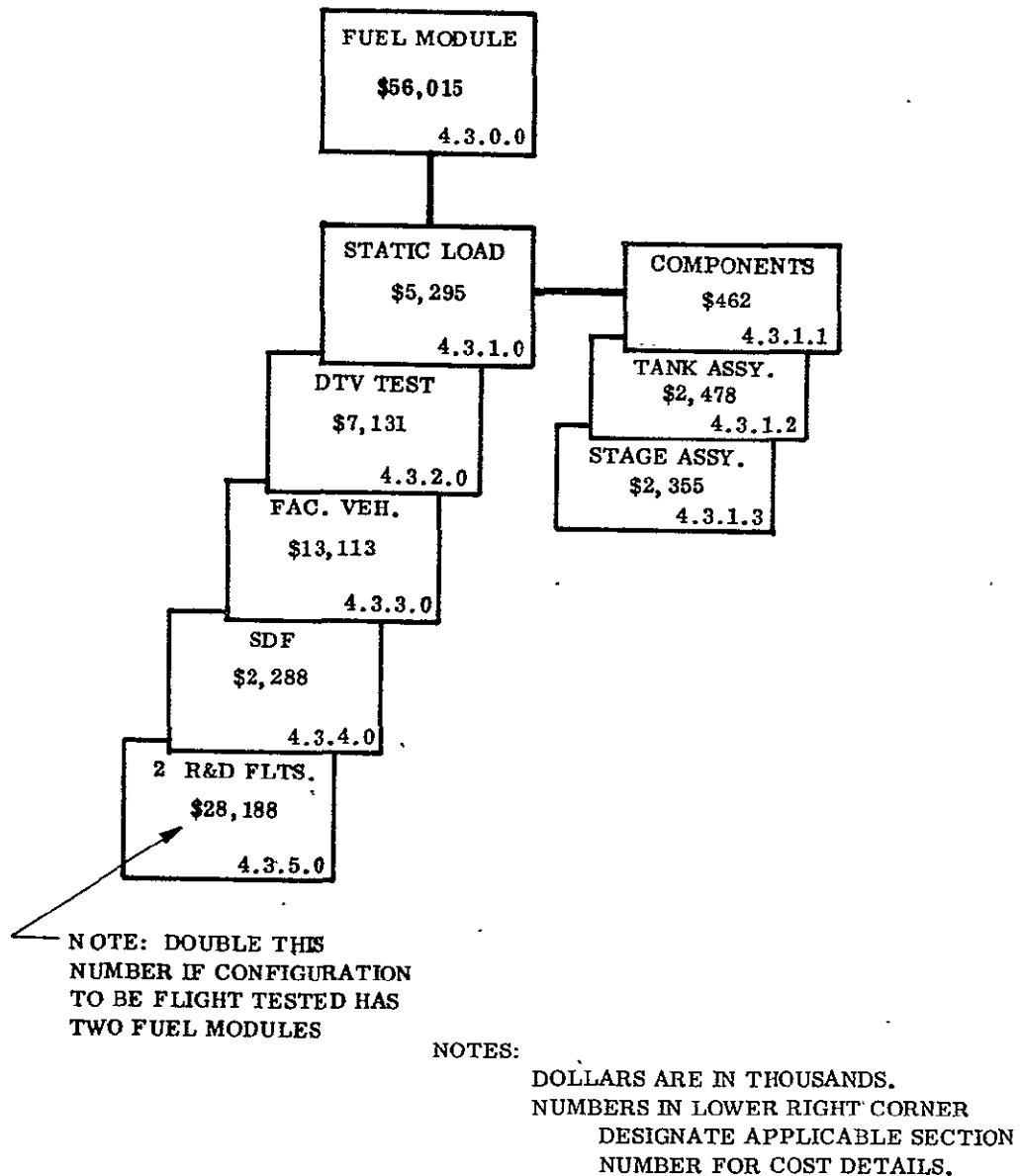


FIGURE 4.3.0.0-1 MLLV INJECTION STAGE FUEL MODULE COST DEVELOPMENT
TEST, "B" COST

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4.3.1 Static Load Test - Injection Stage - Fuel Module

The total cost of conducting all of the static load test for the injection stage fuel module is displayed in Table 4.3.1.0-I. In addition, Figure 4.3.1.0-1 displays the cost and sub-paragraph number of the various components that require static testing. Sections 4.3.1.1 through 4.3.1.3 reflects the cost for the tank assembly, stage assembly and other components, which include the necessary material and labor to accomplish the following functions:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture fabrication
4. Load fixture installation
5. Plumbing installation
6. Instrumentation installation
7. Mechanical checkout
8. Electrical checkout
9. Conduct the test
10. Teardown effort

4. 3.1 (Continued)

c. Material and Parts

1. Raw material
2. Mechanical components
3. Electrical transducers
4. Electrical components and equipment
5. Test specimen (from "C" cost)

d. Retest Costs

Parts, materials and labor costs

The test facilities that are to be utilized for the single stage vehicle are considered adequate to accommodate the fuel module; therefore, no additional facility or equipment costs were added for static testing of the fuel module.

STATIC LOAD TEST - FUEL MODULE

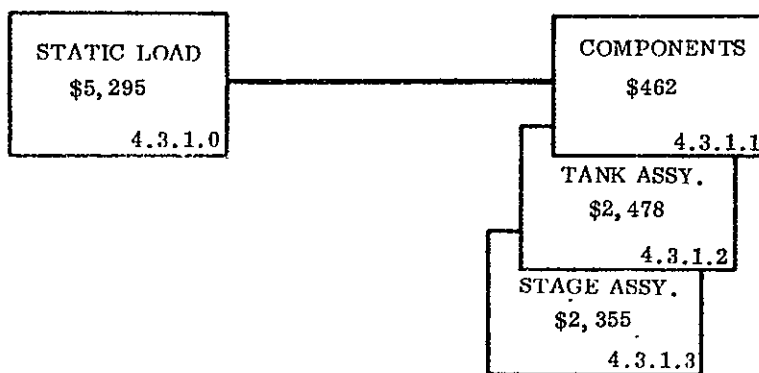
TABLE 4.3.1.0-I
MLLV COST SUMMARY

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		2									2
PROGRAM PLAN.& REPT.	2	5								2	5
INDUSTRIAL RELATIONS		1									1
ENGINEERING			4	51						4	51
LAB TECHNICIANS											
TOOLING											
PRODUCTION			10	96						10	96
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	5						1	5
FACILITIES											
DIRECT DIST			3	31						3	31
TRAINING				1							1
TOTAL DIRECT LABOR	2	8	18	184						20	192
MATERIAL				17							17
LOGISTIC HARDWARE				*5080							5,080
EURDEN				6							6
TOTAL MATERIAL				5103							5,103
TOTAL OTHER											
TOTAL COST		8		5287							5,295

* SPECIMEN



NOTES:

DOLLARS ARE IN THOUSANDS.

NUMBERS IN LOWER RIGHT CORNER

DESIGNATE APPLICABLE SECTION

NUMBER FOR COST DETAILS.

FIGURE 4.3.1.0-1 MLLV INJECTION STAGE FUEL MODULE STATIC LOAD COST DEVELOPMENT TEST, "B" COSTS

4.3.1.1 Component Testing - Static Load Test

STATIC LOAD TEST - COMPONENTS - FUEL MODULE

TABLE 4.3.1.1-I
MLLV COST SUMMARY

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE				*462							462
BURDEN											
TOTAL MATERIAL				462							462
TOTAL OTHER											
TOTAL COST				462							462

* SPECIMEN

4.3.1.2 Tank Assembly – Static Load Test

TABLE 4.3.1.2-I

MLLV COST SUMMARY-Static Load Test.- Tank Assembly - Fuel Module A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.	1	2								1	2
INDUSTRIAL RELATIONS											
ENGINEERING			1	14						1	14
LAB TECHNICIANS											
TOOLING											
PRODUCTION			2	22						2	22
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A				1							1
FACILITIES											
DIRECT DIST			1	7						1	7
TRAINING											
TOTAL DIRECT LABOR	1	2	4	44						5	46
MATERIAL				2							2
LOGISTIC HARDWARE				*2429							2,429
BURDEN				1							1
TOTAL MATERIAL				2,432							2,432
TOTAL OTHER											
TOTAL COST		2		2,476							2,478

* SPECIMEN

MLLV

PART I

Static Load - Tank Assembly - Fuel Module
ASSEMBLY OR SYSTEM

TABLE 4.3.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	1,192		
Logistics			
Laboratory Technician			
Production	2,242		
Tooling			
Manufacturing Test			
Q&RA	113		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>3,547</u>		
Program Executive		43	\$508
Program Planning & Reporting		106	1,252
Industrial Relations		<u>23</u>	<u>224</u>
Total Labor - Part I		<u>172</u>	<u>1,984</u>
<u>Material</u>			
Program Planning & Reporting			1
Industrial Relations			<u>2</u>
Material Subtotal			3
Material & Administrative Burden			<u>1</u>
Total Material			<u>4</u>
TOTAL COST - PART I			<u>\$1,988</u>

TABLE 4.3.1.2-III

Fuel Module

MLLV PART II COST SUMMARY-Static Load Test - Tank Assembly

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	1	14							1	14
LAB TECHNICIANS										
TOOLING										
PRODUCTION							2	22	2	22
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A								1		1
DIRECT DIST							1	7	1	7
TRAINING										
TOTAL DIRECT LABOR	1	14					3	30	4	44
MATERIAL				*2429				2		2,431
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				2,429				2		2,431
MAT. & ADM. BURDEN								1		1
TOTAL MATERIAL				2,429				3		2,432
TOTAL PART II COST		14		2,429				33		2,476

* Specimen

MLLV
R & D TEST COST
NON-RECURRING

Static Load - Tank Assembly - Fuel Module
CONDUCT STATIC LOAD TEST

TABLE 4.3.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
Engineering	1,047	\$12
Retest Allowance	<u>145</u>	<u>2</u>
TOTAL COST	<u><u>1,192</u></u>	<u><u>\$14</u></u>

MLLV
R & D TEST COST
NON-RECURRING

Static Load - Tank Assembly - Fuel Module
CONDUCT STATIC LOAD TEST

TABLE 4.3.1.2-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	1,820	\$18
(2) Retest Allowance	422	4
Subtotal	2,242	22
(3) Direct Distributable	717	7
Subtotal	2,959	29
(4) Training	33	0
Subtotal	2,992	29
(5) Q&RA	113	1
TOTAL LABOR	3,105	\$30
<u>Material</u>		
(6) Raw Material & Parts		\$2
(7) Q&RA		--
Material Subtotal		2
(8) Material & Admin. Burden		1
TOTAL MATERIAL		3
TOTAL COST		\$33

4.3.1.3 Stage Assembly - Static Load Test

TABLE 4.3.1.3-I

MLLV COST SUMMARY Static Load Test - Stage Assembly

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		2									2
PROGRAM PLAN. & REPT.	1	3								1	3
INDUSTRIAL RELATIONS		1									1
ENGINEERING			3	37						3	37
LAB TECHNICIANS											
TOOLING			8	74						8	74
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	4						1	4
FACILITIES											
DIRECT DIST			2	24						2	24
TRAINING				1							1
TOTAL DIRECT LABOR	1	6	14	140						15	146
MATERIAL				15							15
LOGISTIC HARDWARE				*2189							2,189
BURDEN				5							5
TOTAL MATERIAL				2209							2209
TOTAL OTHER											
TOTAL COST		6		2,349							2,355

* SPECIMEN

MLLV

PART I

Static Load Test - Stage Assembly - Fuel Module

ASSEMBLY OR SYSTEM

TABLE 4.3.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	3,139		
Logistics			
Laboratory Technician			
Production	7,657		
Tooling			
Manufacturing Test			
Q&RA	383		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>11,179</u>		
Program Executive		134	\$1,583
Program Planning & Reporting		335	3,956
Industrial Relations		<u>73</u>	<u>710</u>
Total Labor - Part I		<u>542</u>	\$6,249
<u>Material</u>			
Program Planning & Reporting			6
Industrial Relations			<u>7</u>
Material Subtotal			13
Material & Administrative Burden			<u>4</u>
Total Material			<u>17</u>
TOTAL COST - PART I			<u>\$6,266</u>

TABLE 4.3.1.3-III

MLLV PART II COST SUMMARY Static Load Test - Stage Assembly

Fuel Module

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	3	37							3	37
LAB TECHNICIANS										
TOOLING										
PRODUCTION							8	74	8	74
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							1	4	1	4
DIRECT DIST							2	24	2	24
TRAINING								1		1
TOTAL DIRECT LABOR	3	37					11	103	14	140
MATERIAL				*2,189				15		2,204
LAB. TECHNICIANS										
Specimen										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				2,189				15		2,204
MAT. & ADM. BURDEN								5		5
TOTAL MATERIAL				2,189				20		2,209
TOTAL PART II COST		37		2,189				123		2,349

* Specimen - See "C" Cost

MLLV
R & D TEST COST
NON-RECURRING

Stage Assembly - Fuel Module
CONDUCT STATIC LOAD TEST

TABLE 4.3.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands) <u>Dollars</u>
Engineering	2,760	\$33
Retest Allowance	<u>379</u>	<u>4</u>
TOTAL COST	<u>3,139</u>	<u>\$37</u>

MLLV
R & D TEST COST
NON-RECURRING

Stage Assembly - Fuel Module
CONDUCT STATIC LOAD TEST
TABLE 4.3.1,3-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	6,280	\$61
(2) Retest Allowance	<u>1,377</u>	<u>13</u>
Subtotal	7,657	74
(3) Direct Distributable	<u>2,451</u>	<u>24</u>
Subtotal	10,108	98
(4) Training	<u>111</u>	<u>1</u>
Subtotal	10,219	99
(5) Q&RA	<u>383</u>	<u>4</u>
TOTAL LABOR	<u>10,602</u>	<u>\$103</u>
<u>Material</u>		
(6) Raw Material & Parts		\$
(7) Q&RA		<u>15</u>
Material Subtotal		15
(8) Material & Admin. Burdon		5
TOTAL MATERIAL		<u>\$20</u>
TOTAL COST		<u>\$123</u>

4.3.2 Dynamic Testing - Injection Stage - Fuel Module

The total cost for performing the dynamic tests on the injection stage fuel module are displayed in Table 4.3.2.0-I. These costs include the labor and material to accomplish the following functions:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture - fabrication and installation
4. Plumbing installation
5. Instrumentation installation
6. Mechanical checkout
7. Electrical checkout
8. Conduct the test
9. Teardown effort

c. Material and Parts

1. Raw materials
2. Mechanical components
3. Electrical transducers

4. 3. 2 (Continued)

4. Electrical components and equipment

5. Test specimen (from "C" costs)

d. Retest

Parts, materials and labor costs

The test facilities and necessary equipment to conduct dynamic testing of the injection stage - fuel module are displayed in Table 4. 3. 2. 0-I. These costs are additive to the dynamic test facility cost of the single stage vehicle, and injection stage - engine module, as that vehicle combination carries the majority of the costs associated with dynamic testing.

TABLE 4.3.2.0-I

MLLV COST SUMMARY

Dynamic Test - Fuel Module

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES						425					425
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR						425					425
MATERIAL											
LOGISTIC HARDWARE				*6706							6,706
BURDEN											
TOTAL MATERIAL				6706							6,706
TOTAL OTHER											
TOTAL COST				6,706		425					7,131

* Specimen

MLLV
DYNAMIC TEST - FUEL MODULE

TABLE 4.3.2.0-II

Manhours for conducting Dynamic Test on Fuel Module are insignificant. Therefore the only costs involved for testing fuel module are:

Specimen Cost	\$6,706
Additional Facility Cost	<u>425</u>
Total Cost Fuel Module	<u><u>\$7,131</u></u>

4.3.3 Facility Checkout Module - Injection Stage - Fuel Module

The facility checkout injection - fuel module is defined as the test article that will be used to checkout the following:

- a. The manufacturing tools, facilities and equipment
- b. All R&D test facilities and equipment
- c. Handling and transportation equipment
- d. Launch complex facilities, and support area
- e. All GSE (manufacturing facility and launch facility)
- f. All processes and procedures

The primary objective of the facility vehicle is to achieve a state of operational readiness prior to processing of the flight modules. The costs associated with this facility vehicle are displayed in Table 4.3.3.0-I. The facility module consists of the following:

- a. Fuel module structure
- b. Systems
- c. Transportation from the manufacturing plant to the launch site.
- d. Launch cycle cost (based on one-year cost to checkout the facility)
- e. Propellant cost

TABLE 4.3.3.0-I

MLLV COST SUMMARY

Facility Vehicle - Fuel Module

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									13,113		13,113
TOTAL COST									13,113		\$13,113

MLLV
NON-RECURRING
R&D COST

Facility Vehicle - Fuel Module

TABLE 4.3.3.0-II

<u>Element of Cost</u>	(In Thousands) <u>Dollars</u>
Structures	\$4,618
Systems	603
Launch Operations	7,527
Propellant	<u>365</u>
TOTAL COST	<u>\$13,113</u>

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4.3.4 Systems Development Facility (Breadboard) - Injection Stage - Fuel Module

The system development breadboard facility for the fuel module will provide for extensive testing, evaluation and verification of components, sub-systems and systems under controlled conditions that approximate those at the launch site.

Existing facilities at Michoud will be used to house the breadboard. The equipment for these tests will primarily consist of the elements of vehicle and GSE hardware and/or simulators that make up the breadboard plus the computer complex.

The costs associated with the SDF for the fuel module are displayed in Table 4.3.4.0-I.

TABLE 4.3.4.0-I
MLLV COST SUMMARY

SDF - Fuel Module

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									2,288		2,288
TOTAL COST									2,288		\$2,288

MLLV
NON-RECURRING COST
R&D TEST FACILITIES

Systems Development Facility - Fuel Module

TABLE 4.3.4.0-II

<u>Element of Cost</u>	(In Thousands) <u>Dollars</u>
Equipment	\$1,750
Operation (1)	<u>538</u>
TOTAL SDF	<u>\$2,288</u>

(1) operation cost is estimated for a five year period

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4. 3. 5 R&D Flight Modules - Injection Stage - Fuel Module

The two R&D injection stage fuel modules are required for the final qualification testing that must precede the manned flights in order to qualify the system:

The prime objectives of flight tests are:

- a. Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground testing.
- b. Acquisition of flight data and correlation of these data with the results of ground tests.
- c. Flight verification of the launch vehicle and ground support equipment prior to manned flight.
- d. Flight verification of stage subsystems affecting crew safety prior to manned flight.
- e. Ground crew training.

Individual modules (specimens) costs were obtained from the "C" category of estimates, with allowances for the additional R&D instrumentation.

The costs for the two R&D fuel modules are shown in Table 4. 3. 5. 0-I. These costs include all of the cost associated with the fuel module hardware, additional R&D instrumentation, SE&I and launch cycle costs (the launch costs for each R&D flight are based on a nine month cycle), in addition, these costs include all appropriate transportation cost, facility and equipment maintenance costs.

TWO R&D FLIGHTS - FUEL MODULE

TABLE 4.3.5.0-I
MLLV COST SUMMARY

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
EURDEN											
TOTAL MATERIAL											
TOTAL OTHER									28188		28,188
TOTAL COST									28188		28,188

TABLE 4.3.5.0-II
MLLV

DEVELOPMENTAL COSTS

TWO R&D FLIGHTS - FUEL MODULE
(DOLLARS IN THOUSANDS)

<u>Element of Cost</u>	<u>No. 1</u>	<u>No. 2</u>
Stage Hardware (1)	\$ 9,596	\$ 8,732
Propellants	365	365
Launch Operations	<u>4,565</u>	<u>4,565</u>
	\$14,526	\$13,662
TOTAL COSTS OF TWO R&D FLIGHTS	\$28,188	

(1) Includes Transportation and Facility and Equipment
Maintenance Costs

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4.4 SOLID ROCKET MOTOR STAGE TESTING

The summary costs for testing the Solid Rocket Motor Stages are displayed in Table 4.4.0.0-I. These costs include not only the cost associated with conducting the test but all the costs of the test specimens as well. Specimen costs were developed from the recurring costs contained in Book C of this volume. Figure 4.4.0.0-1 displays the total cost of the Solid Rocket Motor Stage Testing by type of test, and the appropriate sub-paragraph where the cost information is located.

TABLE 4.4.0.0-I

MLLV COST SUMMARY

SRM STAGE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	36	419								36	419
PROGRAM PLAN.& REPT.	88	1,027								88	1,027
INDUSTRIAL RELATIONS	17	178								17	178
ENGINEERING			672	7,928						672	7,928
LAB TECHNICIANS			6	55						6	55
TOOLING											
PRODUCTION			78	755						78	755
MANUFACTURING TEST			964	9,360						964	9,360
MANUFACTURING TECH.											
Q & R A			156	1,526						156	1,526
FACILITIES											
DIRECT DIST			26	259						26	259
TRAINING			2	10						2	10
TOTAL DIRECT LABOR	141	1,624	1,904	19,893						2,045	21,517
MATERIAL				3,617							3,617
LOGISTIC HARDWARE				94,986							94,986
BURDEN				164							164
TOTAL MATERIAL				98,767							98,767
TOTAL OTHER				11,337	12,750				231,401		255,488
TOTAL COST		1,624		129,997	12,750				231,401		375,772

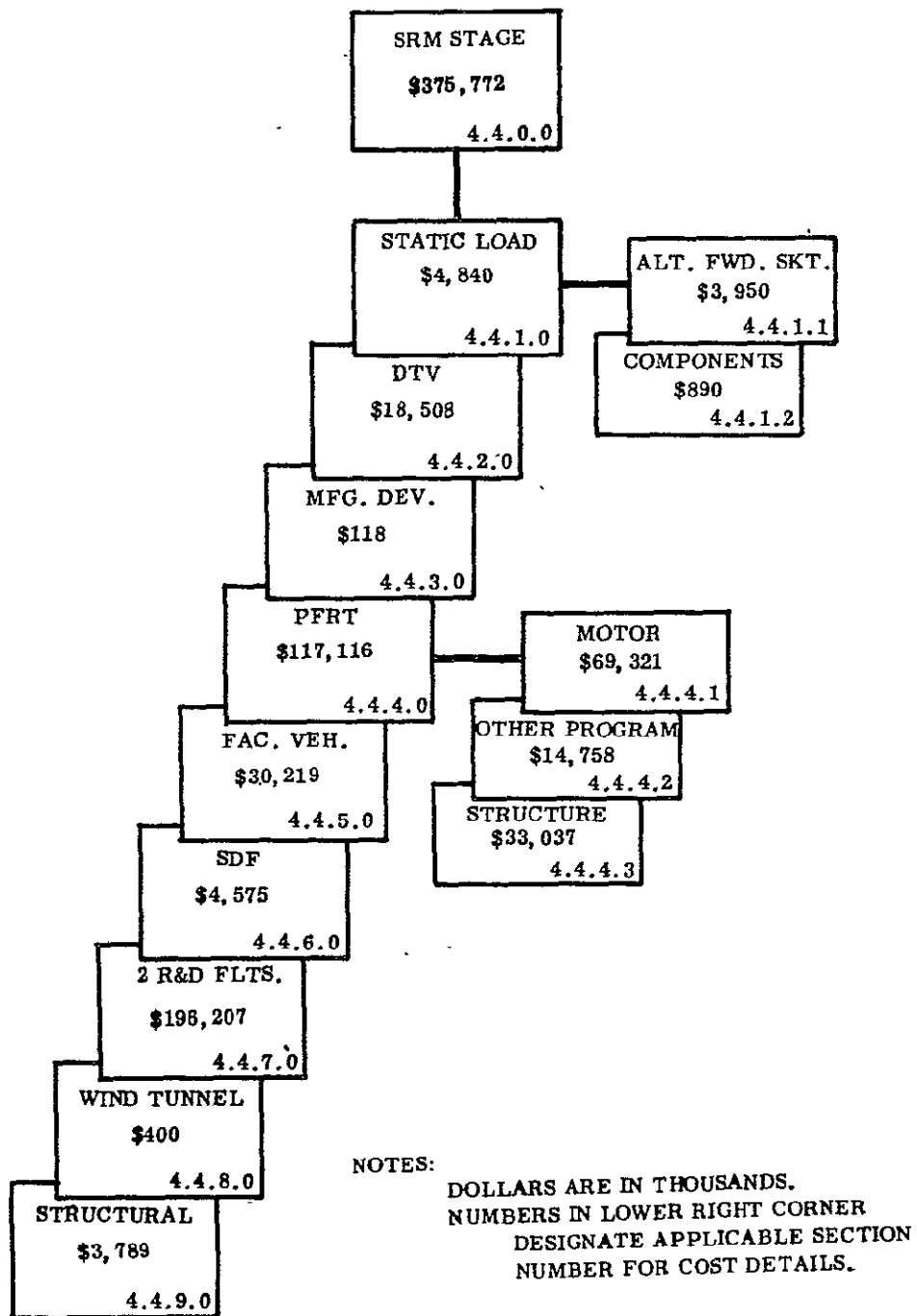


FIGURE 4.4.0.0-1 MLLV SOLID MOTOR STAGE COST DEVELOPMENT
TEST "B" COSTS

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4.4.1 Static Load Test - SRM Stage

Total cost of conducting all of the static load tests for the SRM stage vehicle are shown in Table 4.4.1.0-I. In addition, Figure 4.4.1.0-I displays the costs and sub-paragraph number of the various components that require static testing. Paragraph 4.4.1.1 and paragraph 4.4.1.2 reflect the costs for the alternate forward skirt and other components, which include the labor, material and tooling to accomplish the following:

- a. Engineering
 - 1. Mechanical and electrical design
 - 2. Drafting and support
 - 3. Liaison
 - 4. Conduct the test
 - 5. Test reports
- b. Manufacturing
 - 1. Facility checkout and preparation
 - 2. Specimen installation
 - 3. Load fixture fabrication
 - 4. Load fixture installation
 - 5. Plumbing installation
 - 6. Instrumentation installation
 - 7. Mechanical checkout
 - 8. Electrical checkout
 - 9. Conduct the test
 - 10. Teardown effort

4.4.1 (Continued)

c. Material and Parts

1. Raw material
2. Mechanical components
3. Electrical transducers
4. Electrical components and equipment
5. Test specimen (from "C" costs)

d. Retest Allowance

Parts, materials and labor

The test facilities and equipment that are required to produce the SRM stage and those required to static load test the single stage vehicle will be utilized to static load test the SRM stage components.

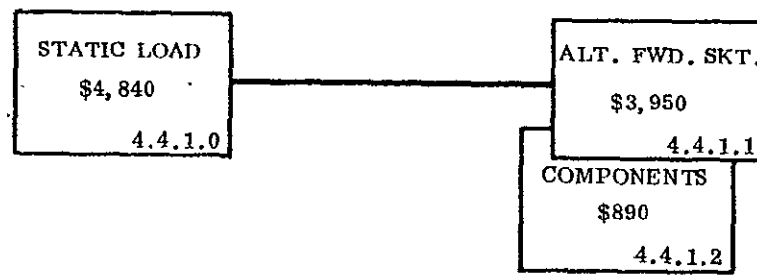
TABLE 4.4.1.0-1

MLLV COST SUMMARY STATIC LOAD TEST (DELTA) - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	10								1	10
PROGRAM PLAN.& REPT.	3	28								3	28
INDUSTRIAL RELATIONS		4									4
ENGINEERING			26	300						26	300
LAB TECHNICIANS											
TOOLING											
PRODUCTION			47	452						47	452
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2	22						2	22
FACILITIES											
DIRECT DIST			14	144						14	144
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	4	42	90	925						94	967
MATERIAL				248							248
LOGISTIC HARDWARE				3540							3540
BURDEN				85							85
TOTAL MATERIAL				333							333
TOTAL OTHER											
TOTAL COST		42		4,798							4,840



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 4.4.1.0-1 MLLV SOLID MOTOR STAGES STATIC LOAD COST.
DEVELOPMENT TEST, "R" COST

4.4.1.1 Alternate Forward Skirt (Heavy Weight Forward Skirt) – Static
Load Test

TABLE 4.4.1.1-I

MLLV COST SUMMARY STATIC LOAD TEST (DELTA) FORWARD SKIRT SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	10								1	10
PROGRAM PLAN. & REPT.	2	26								2	26
INDUSTRIAL RELATIONS		4									4
ENGINEERING			24	279						24	279
LAB TECHNICIANS											
TOOLING											
PRODUCTION			45	436						45	436
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2	22						2	22
FACILITIES											
DIRECT DIST			14	140						14	140
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	3	40	86	883						89	923
MATERIAL				57							57
LOGISTIC HARDWARE				2950							2,950
BURDEN				20							20
TOTAL MATERIAL				77							77
TOTAL OTHER											
TOTAL COST		40		3,910							3,950

MLLV

PART I

STATIC LOAD TEST - DELTA - FORWARD SKIRT - SRM
ASSEMBLY OR SYSTEM

TABLE 4.4.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	23,616		
Logistics			
Laboratory Technician			
Production	44,873		
Tooling			
Manufacturing Test			
Q&RA	2,243		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>70,732</u>		
Program Executive		849	10,027
Program Planning & Reporting		2,122	25,061
Industrial Relations		460	4,471
Total Labor - Part I		<u>3,431</u>	<u>39,559</u>
<u>Material</u>			
Program Planning & Reporting			42
Industrial Relations			46
Material Subtotal			88
Material & Administrative Burden			30
Total Material			<u>118</u>
TOTAL COST - PART I			<u>39,667</u>

TABLE 4.4.1.1-III

MLLV PART II COST SUMMARY STATIC LOAD TEST DELTA FORWARD SKIRT SRM ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	24	279							24	279
LAB TECHNICIANS										
TOOLING										
PRODUCTION							45	436	45	436
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							2	22	2	22
DIRECT DIST							14	140	14	140
TRAINING							1	6	1	6
TOTAL DIRECT LABOR	24	279					62	604	86	883
MATERIAL				*2950				56		3,006
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A								1		1
SUBTOTAL				2,950				57		3,007
MAT. & ADM. BURDEN								20		20
TOTAL MATERIAL				2,950				77		3,027
TOTAL PART II COST		279		2,950				681		3,910

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING
DELTA COMPONENTS - SRM
CONDUCT STATIC LOAD TEST

TABLE 4.4.1.1-IV

(In Thousands)		
<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Engineering	20,760	245
Retest Allowance	<u>2,856</u>	<u>34</u>
TOTAL COST	<u>23,616</u>	<u>279</u>

MLLV
R & D TEST COST
NON-RECURRING

DELTA - FORWARD SKIRT - SRM
CONDUCT STATIC LOAD TEST
TABLE 4.4.1.1-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	36,557	355
(2) Retest Allowance	8,316	81
Subtotal	44,873	436
(3) Direct Distributable	14,360	140
Subtotal	59,233	576
(4) Training	652	6
Subtotal	59,885	582
(5) Q&RA	2,243	22
TOTAL LABOR	62,128	604
<u>Material</u>		
(6) Raw Material & Parts		56
(7) Q&RA		1
Material Subtotal		57
(8) Material & Admin. Burden		20
TOTAL MATERIAL		77
TOTAL COST		681

4.4.1.2 Component Testing - Static Load Test

TABLE 4.4.1.2-I

MLLV COST SUMMARY STATIC LOAD TEST - (DELTA) - COMPONENTS - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.	1	2								1	2
INDUSTRIAL RELATIONS											
ENGINEERING			2	21						2	21
LAB TECHNICIANS											
TOOLING											
PRODUCTION			2	16						2	16
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST				4							4
TRAINING				1							1
TOTAL DIRECT LABOR	1	2	4	42						5	44
MATERIAL				191							191
LOGISTIC HARDWARE				*590							590
BURDEN				65							65
TOTAL MATERIAL				256							256
TOTAL OTHER											
TOTAL COST		2		888							890

* SPECIMEN

MLLV

PART I

STATIC LOAD TEST - DELTA - COMPONENTS - SRM
 ASSEMBLY OR SYSTEM

TABLE 4.4.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	1,748		
Logistics			
Laboratory Technician			
Production	1,598		
Tooling			
Manufacturing Test			
Q&RA	79		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>3,425</u>		
Program Executive		41	484
Program Planning & Reporting		103	1,216
Industrial Relations		22	214
Total Labor - Part I		<u>166</u>	<u>1,914</u>
<u>Material</u>			
Program Planning & Reporting			2
Industrial Relations			3
Material Subtotal			<u>5</u>
Material & Administrative Burden			1
Total Material			<u>6</u>
TOTAL COST - PART I			<u>1,920</u>

TABLE 4.4.1.2-III

SRM

MLLV PART II COST SUMMARY STATIC LOAD TEST - DELTA - COMPONENTS , A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	2	21							2	21
LAB TECHNICIANS										
TOOLING										
PRODUCTION							2	16	2	16
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A										
DIRECT DIST								4		4
TRAINING								1		1
TOTAL DIRECT LABOR	2	21					2	21	4	42
MATERIAL				*590				191		781
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				590				191		781
MAT. & ADM. BURDEN								65		65
TOTAL MATERIAL				590				256		846
TOTAL PART II COST		21		590				277		888

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

DELTA COMPONENTS - SRM
CONDUCT STATIC LOAD TEST

TABLE 4.4.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)
		<u>Dollars</u>
Engineering	1,533	18
Retest Allowance	<u>215</u>	<u>3</u>
TOTAL COST	<u>1,748</u>	<u>21</u>

MLLV
R & D TEST COST
NON-RECURRING

DELTA - COMPONENTS - SRM
CONDUCT STATIC LOAD TEST

TABLE 4.4.1.2-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	971	9
(2) Retest Allowance	627	7
Subtotal	1,598	16
(3) Direct Distributable	511	4
Subtotal	2,109	20
(4) Training	23	1
Subtotal	2,132	21
(5) Q&RA	79	0
TOTAL LABOR	2,211	21
<u>Material</u>		
(6) Raw Material & Parts		191
(7) Q&RA		
Material Subtotal		191
(8) Material & Admin. Burden		65
TOTAL MATERIAL		256
TOTAL COST		277

4.4.2 Dynamic Testing - SRM Stage

The total cost for performing the simulation of the SRM stages on the dynamic test on the vehicle are displayed in Table 4.4.2.0-I, which includes the labor and material to accomplish the following functions:

a. Engineering

1. Mechanical and electrical design
2. Drafting and support
3. Liaison
4. Conduct the test
5. Test reports

b. Manufacturing

1. Facility checkout and preparation
2. Specimen installation
3. Load fixture - fabrication and installation
4. Plumbing installation
5. Instrumentation installation
6. Mechanical checkout
7. Electrical checkout
8. Conduct the test
9. Teardown effort

c. Material and Parts

1. Raw materials
2. Mechanical components
3. Electrical transducers

4.4.2 (Continued)

4. Electrical components and equipment

5. Test specimen (from "C" costs)

d. Retest Allowance

Parts, Materials and labor costs

Also additional costs for the dynamic test facilities and the capital equipment required for simulation of the SRM effects on the main stage dynamic test are included. The maintenance costs of the test facility are not increased from the single stage dynamic testing costs.

TABLE 4.4.2.0-I

MLLV COST SUMMARY

DYNAMIC TEST (DELTA) - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	8								1	8
PROGRAM PLAN.& REPT.	2	20								2	20
INDUSTRIAL RELATIONS		3									3
ENGINEERING			18	211						18	211
LAB TECHNICIANS											
TOOLING											
PRODUCTION			31	303						31	303
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			6	61						6	61
FACILITIES											
DIRECT DIST			10	97						10	97
TRAINING			1	4						1	4
TOTAL DIRECT LABOR	3	31	66	676						69	707
MATERIAL				219							219
LOGISTIC HARDWARE				4757							4,757
BURDEN				75							75
TOTAL MATERIAL				5,051							5,051
TOTAL OTHER						12,750					12,750
TOTAL COST		31		5,727		12,750					18,508

MLLV
NON-RECURRING

PART I
DYNAMIC TEST - (DELTA) - SRM
ASSEMBLY OR SYSTEM

TABLE 4.4.2.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	17,900		
Logistics			
Laboratory Technician			
Production	31,163		
Tooling			
Manufacturing Test			
Q&RA	6,232		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>55,295</u>		
Program Executive		664	7,842
Program Planning & Reporting		1,659	19,593
Industrial Relations		<u>359</u>	<u>3,489</u>
Total Labor - Part I		<u>2,682</u>	<u>30,913</u>
<u>Material</u>			
Program Planning & Reporting			33
Industrial Relations			<u>36</u>
Material Subtotal			69
Material & Administrative Burden			<u>23</u>
Total Material			<u>92</u>
TOTAL COST - PART I			<u>31,005</u>

TABLE 4.4.2.0-III

MLLV PART II COST SUMMARY DYNAMIC TEST - (DELTA) - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	18	211							18	211
LAB TECHNICIANS										
TOOLING										
PRODUCTION							31	303	31	303
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A							6	61	6	61
DIRECT DIST							10	97	10	97
TRAINING							1	4	1	4
TOTAL DIRECT LABOR	18	211					48	465	66	676
MATERIAL				*4,757				217		4,974
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A								2		2
SUBTOTAL				4,757				219		4,976
MAT. & ADM. EXPEN								75		75
TOTAL MATERIAL				4,757				294		5,051
TOTAL PART II COST		211		4,757				759		5,727

* SPECIMEN

MLLV
R & D TEST COST
NON-RECURRING

CONDUCT DYNAMIC TEST (DELTA) - SRM

TABLE 4.4.2.0-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering	16,110	190
Retest Allowance	<u>1,790</u>	<u>21</u>
TOTAL COST	<u>17,900</u>	<u>211</u>

MLLV
R & D TEST COST
NON-RECURRING

CONDUCT DYNAMIC TEST -(DELTA) - SRM

TABLE 4.4.2.0-V

(IN THOUSANDS)

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Manufacturing	27,424	267
(2) Retest Allowance	3,739	36
Subtotal	31,163	303
(3) Direct Distributable	9,972	97
Subtotal	41,135	400
(4) Training	452	4
Subtotal	41,587	404
(5) Q&RA	6,232	61
TOTAL LABOR	47,819	465
<u>Material</u>		
(6) Raw Material & Parts		217
(7) Q&RA		2
Material Subtotal		219
(8) Material & Admin. Burden		75
TOTAL MATERIAL		294
TOTAL COST		759

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4. 4. 3 Manufacturing Development Test - SRM Stage

The manufacturing development task for the SRM stage is directed toward the development and implementation of fabrication and assembly processes.

Defined in broad terms, the procedure is as follows:

- a. Determine manufacturing development requirements through coordination and review of engineering drawings and specifications, present methods and existing manufacturing capabilities.
- b. Establish suitable manufacturing methods. Document and coordinate these methods with applicable organizations.
- c. Define equipment requirements, tooling criteria, training requirements, and establish step-by-step procedures for critical manufacturing.
- d. Coordinate with Factory, Manufacturing Engineering, Facilities Training, etc., to assist them in the implementation and proper application of newly developed methods.

Table 4. 4. 3. 0-I displays the cost associated with this function for the SRM stage vehicle.

TABLE 4.4.3.0-I

MLLV COST SUMMARY MANUFACTURING DEVELOPMENT SRM STRUCTURE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	10								1	10
PROGRAM PLAN.& REPT.		3									3
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS			6	55						6	55
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1	15						1	15
FACILITIES											
DIRECT DIST			2	18						2	18
TRAINING											
TOTAL DIRECT LABOR	1	13	9	89						10	102
MATERIAL				12							12
LOGISTIC HARDWARE											
BURDEN				4							4
TOTAL MATERIAL				16							16
TOTAL OTHER											
TOTAL COST		13		105							118

MLLV
DEVELOPMENT COST
NON-RECURRING

PART I
MANUFACTURING DEVELOPMENT SRM
ASSEMBLY OR SYSTEM
TABLE 4.4.3.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician	5,700		
Production			
Tooling			
Manufacturing Test			
Q&RA	1,521		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>7,221</u>		
Program Executive		867	10,239
Program Planning & Reporting		217	2,563
Industrial Relations		<u>47</u>	<u>457</u>
Total Labor - Part I		<u>1,131</u>	<u>13,259</u>
<u>Material</u>			
Program Planning & Reporting			4
Industrial Relations			<u>5</u>
Material Subtotal			9
Material & Administrative Burden			<u>3</u>
Total Material			<u>12</u>
TOTAL COST - PART I			<u>13,271</u>

MLLV
DEVELOPMENT COST
NON-RECURRING
MANUFACTURING DEVELOPMENT SRM

TABLE 4.4.3.0-III

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Lab Technician	5,700	55,404
Direct Distributable	1,824	17,729
Subtotal	7,524	73,133
Training	83	807
Subtotal	7,607	73,940
Q&RA	1,521	14,784
TOTAL LABOR	9,128	88,724
<u>Material</u>		
Lab Tech.		11,970
Q&RA		456
Material Subtotal		12,426
Material and Administrative Burden		4,225
Total Material		16,651
TOTAL COST		105,375

4.4.4 SRM Motor Pre-Flight Rating Testing (PFRT)

The tests listed herein are the tests that are required by the SRM manufacturer. The test categories are structure, motor, and other program costs as shown in Figure 4.4.4.0-1.

Structure

1. Structural components
2. Electrical system
3. Instrumentation
4. Separation components
5. Destruct charges and firing components

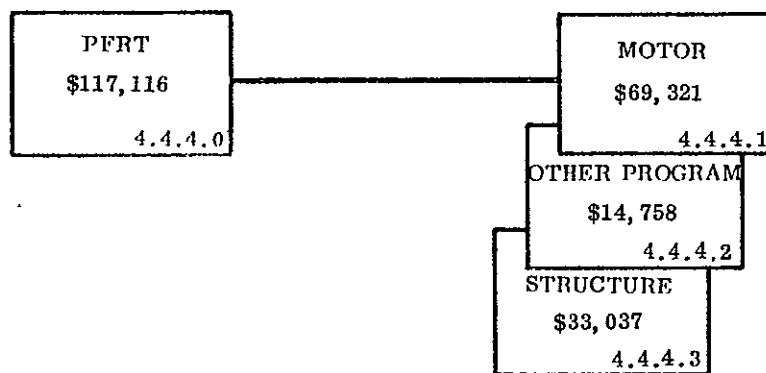
Motor Costs

1. Chamber
2. Nozzles
3. Case installation
4. Propellant and liner materials
5. Igniter
6. Shipping
7. Manufacturing labor
8. Process and test
9. Inspection

Other Program Costs

1. Management and administration
2. Engineering
3. Test equipment design
4. Component development
5. Special test equipment
6. Test facilities
7. General and administrative expenses

These costs are displayed by Table 4.4.4.0-I.



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 4.4.4.0-1 MLLV SRM PRE-FLIGHT RATING TEST (PFRT) COSTS
 DEVELOPMENT TEST, "B" COSTS

TABLE 4.4.4.0-I

MLIV COST SUMMARY

TOTAL DEV/PERT - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	33	391								33	391
PROGRAM PLAN.& REPT.	83	976								83	976
INDUSTRIAL RELATIONS	17	171								17	171
ENGINEERING			628	7,415						628	7,415
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST			924	8,972						924	8,972
MANUFACTURING TECH.											
Q & R A			147	1,428						147	1,428
FACILITIES											
DIRECT DIST											
TRAINING.											
TOTAL DIRECT LABOR	133	1,538	1,699	17,815						1,832	19,353
MATERIAL				1,708	8,069						9,777
LOGISTIC HARDWARE				87,986							87,986
BURDEN											
TOTAL MATERIAL				89,694	8,069						97,763
TOTAL OTHER											
TOTAL COST		1,538		89,694	8,069						117,116

* SPECIMEN

TABLE 4.4.4.0-II

MLLV COST SUMMARY DEV/PFRT TEST - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST			502	4,875						502	4,875
MANUFACTURING TECH.											
Q & R A			147	1,428						147	1,428
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR			649	6,303						649	6,303
MATERIAL						8,069					8,069
LOGISTIC HARDWARE				54,959							54,959
BURDEN											
TOTAL MATERIAL				54,959		8,069					63,028
TOTAL OTHER											
TOTAL COST				61,252		8,069					69,321

* SPECIMEN

MLLV
SRM
DEVELOPMENT TESTS
DEV/PFRT
(DOLLARS IN THOUSANDS)

TABLE 4.4.4.0-III

1.	Chamber		20,374
2.	Nozzle:		
	Shell	5,446	
	Ablatives & Exit Cone	9,372	
	Flexible Seal Assembly	2,705	
	Actuators (2/Motor)	858	
	APU (2/Motor)	<u>1,509</u>	19,890
3.	Case Instulation		1,065
4.	Propellant & Linear Materials		11,966
5.	Igniter		357
6.	Transportation		1,297
7.	Manufacturing Labor		
	Process & Test	4,875	
	Inspection	1,428	6,303
	Test Facility	<u> </u>	<u>8,069</u>
	*Total Motor Cost Less Fee		<u><u>69,321</u></u>

* Cost for ten solid rocket motors for PFRT test. Dollar based on Aerojet input of 15 January, 1969.

TABLE 4.4.4.2-I

MLLV COST SUMMARY-DEV/PFRT - OTHER PROGRAM COST - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	33	391								33	391
PROGRAM PLAN.& REPT.	83	976								83	976
INDUSTRIAL RELATIONS	17	171								17	171
ENGINEERING			628	7,415						628	7,415
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST			422	4,097						422	4,097
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	133	1,538	1,050	11,512						1,183	13,050
MATERIAL				* 1,708							1,708
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				1,708							1,708
TOTAL OTHER											
TOTAL COST		1,538		13,220							14,758

* Special Test Fac. 643
 Test Equip. 1,065

MLLV

PART I

DEV/PFRT - OTHER PROGRAM COST - SRM
ASSEMBLY OR SYSTEM

TABLE 4.4.4.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production			
Tooling			
Manufacturing Test			
Q&RA			
Facilities			
Manufacturing Technician			
Total Direct Labor			
Program Executive		33,078	390,652
Program Planning & Reporting		82,695	976,630
Industrial Relations		17,564	170,718
Total Labor - Part I		133,337	1,538,000
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			1,538,000

TABLE 4.4.4.2-III

MLLV PART II COST SUMMARY DEV/PFRT OTHER PROGRAM COST - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING		7,415							628	7,415
LAB TECHNICIANS										
TOOLING										
PRODUCTION										
MANUFACTURING TEST							422	4,097	422	4,097
MANUFACTURING TECH.										
Q & R A										
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	628	7,415					422	4,097	1,050	11,512
* MATERIAL:								1,708		1,708
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL								1,708		1,708
MAT. & ADM. BURDEN										
TOTAL MATERIAL								1,708		1,708
TOTAL PART II COST		7,415						5,805		13,220

* Special Test Equip & Facilities

MLLV
 NON-RECURRING COSTS
 PART II-A DEV/PFRT OTHER PROGRAM COST - SRM

ASSEMBLY OR SYSTEM

DESIGN ENGINEERING

<u>ELEMENT OF COST</u>	<u>TABLE 4.4.4.2-IV</u>	<u>MANHOURS</u>	<u>DOLLARS</u>
BASIC DESIGN		627,857	7,415,000
1. Laboratory Technicians			
Subtotal			
2. Q&RA		_____	_____
TOTAL ENGINEERING LABOR		<u>627,857</u>	<u>7,415,000</u>
MATERIAL			
3. Laboratory Technicians			
4. Q&RA			_____
Subtotal			
5. Material and Adm. Burden			_____
TOTAL MATERIAL			<u>_____</u>
TOTAL ENGINEERING COST			<u>7,415,000</u>

MLLV
SRM
DEVELOPMENT TESTS
DEV/PFRT
(DOLLARS IN THOUSANDS)
TABLE 4.4.4.2- V

* Other Program Costs

1.	Labor	
	Management & Administration	1,538
	Engineering	7,173
	Test Equipment Design	242
2.	Component Development	4,097
3.	Special Test Equipment	1,065
4.	Test Facilities	643
	Total Aerojet other program cost less fee	<u>14,758</u>

* Based on Aerojet input, January 15, 1969

TABLE 4.4.4.3-I

MLLV COST SUMMARY DEV/PFRT TESTS - STRUCTURE & OTHER STAGE HDWE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING.											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE				*33037							33,037
BURDEN											
TOTAL MATERIAL				33,307							33,037
TOTAL OTHER											
TOTAL COST				33,037							33,307

* SPECIMEN

MLLV
SRM
DEV/PFRT
NON-RECURRING
(DOLLARS IN THOUSANDS)

TABLE 4.4.4.3-II

Structure and Other Stage Hardware

*1.	Attach Structure		4,395
*2.	Aft Skirt		1,353
*3.	Fittings		1,011
**4.	Stage Components		
	Heat Shield	2,070	
	Raceway (Tunnel)	620	
	Environmental Control Duct	410	
	Mounting and Fairing	<u>2,200</u>	5,300
**5.	Electrical System		9,400
**6.	Instrumentation		11,000
**7.	Stage Separation		
	Initiation Components		280
**8.	Destruct Charges and Firing Components		<u>298</u>
	Total Cost Less Fee		<u><u>33,037</u></u>

* Cost for three sets of structure and other Stage Hardware for PERT Program

** Cost includes test development cost for these items and three equivalent sets of hardware to be delivered to the SRM contractor for further testing in combination with the SRM PFRT Tests.

4.4.5 Facility Checkout Vehicle - SRM Stage

The facility checkout SRM stage is defined as the test article that will be used to checkout the following:

- a. The SRM stage manufacturing tools, facilities and equipment
- b. All SRM stage related R&D test facilities and equipment
- c. SRM stage handling and transportation equipment
- d. SRM stage launch complex facilities and support areas
- e. All SRM stage GSE (manufacturing facility and launch facility)
- f. All SRM stage processes and procedures

The primary objective of the facility vehicle is to achieve a state of operational readiness prior to processing of the flight vehicles. The costs associated with this facility vehicle are displayed in Table 4.4.5.0-I. The facility vehicle consists of the following types of cost elements:

- a. SRM stage structure
- b. Systems
- c. Transportation from the manufacturing plant to the launch site.
- d. The cost of a larger dummy payload and instrument unit (basically required due to the larger payload capability provided by the solids).
- e. Launch cycle cost (based on one year's cost to check out the facility).

TABLE 4.4.5.0-I

MLLV COST SUMMARY

FACILITY VEHICLE

- SRM STAGE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING.											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									30,219		30,219
TOTAL COST									30,219		30,219

MLLV
NON-RECURRING
R&D COST
FACILITY VEHICLE - SRM STAGE

TABLE 4.4.5.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Structures	5,593
Transportation	26
Dummy payload & IU	1,500
Launch Operations	<u>23,100</u>
Total Cost	<u><u>30,219</u></u>

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4. 4. 6 Systems Development Facility (Breadboard) - SRM Stage

The Systems Development Breadboard Facility operations required for the SRM stage will provide for extensive testing, evaluation, and verification of components, sub-systems and systems under controlled conditions that approximate those at the launch site.

Existing facilities at Michoud will be used to house the breadboard. The equipment for these tests will primarily consist of the elements of vehicle and GSE hardware and/or simulators that make up the breadboard plus the computer complex.

The costs associated with the SDF for the SRM stage vehicle are displayed in Table 4. 4. 6. 0-I.

TABLE 4.4.6.0-I

MLLV COST SUMMARY

SDF - SRM'S

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									4,575		4,575
TOTAL COST									4,575		4,575

MLLV
 NON-RECURRING COST
 R&D TEST FACILITIES
SYSTEMS DEVELOPMENT FACILITY - SRM'S

TABLE 4.4.6.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Equipment	3,500
Operation (1)	<u>1,075</u>
Total SDF	<u><u>4,575</u></u>

(1) Operation Cost is estimated for a five year period.

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4.4.7 R&D Flight SRM Stages

The R&D flight vehicles are the final qualification testing that must precede the manned flights in order to qualify the system. The SRM stages required for the two R&D tests will assist in verifying the vehicle readiness.

The prime objectives of flight tests are:

- a. Evaluation of hardware characteristics and operational procedures which cannot be adequately evaluated by ground testing.
- b. Acquisition of flight data and correlation of these data with the results of ground tests.
- c. Flight verification of the launch vehicle and ground support equipment prior to manned flight.
- d. Flight verification of stage subsystems affecting crew safety prior to manned flight.
- e. Ground crew training.

Each flight space vehicle will be as complete as practicable, i. e., no dummy stage, modules or subsystems, with the exception of a simulated payload.

Individual stage (specimen) costs were obtained from the "C" category estimates with allowances for the additional R&D instrumentation.

The costs for two SRM stage vehicles are shown in Table 4.4.7.0-I. This cost includes all the cost of stage hardware, R&D instrumentation, Instrument Unit, SE&I and Launch Cycle costs (these launch costs for each R&D flight are based on a nine month cycle). In addition these costs include all transportation, facility and equipment maintenance.

TABLE 4.4.7.0-I
MLLV COST SUMMARY

TWO R&D FLIGHTS - 8 SOLID ROCKET MOTORS

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									196,207		196,207
TOTAL COST									196,207		196,207

TABLE 4.4.7.0-II
MLLV

DEVELOPMENTAL COSTS

TWO R&D FLIGHTS - 8 SRMS/FLIGHT
(DOLLARS IN THOUSANDS)

<u>Element of Cost</u>	<u>No. 1</u>	<u>No. 2</u>
Stage Hardware (1)	\$ 78,087	\$ 71,464
For Forward Skirt	2,950	2,950
Launch Operations	8,090	8,090
SE&I	1,150	1,150
Instrumentation	<u>11,136</u>	<u>11,136</u>
	\$101,415	\$ 94,792
TOTAL COSTS OF TWO R&D FLIGHTS	\$196,207	

(1) Includes Transportation and Facility and Equipment Maintenance Costs

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4. 4. 8 Wind Tunnel (Model Tests) - SRM Stage

Models will be used in wind tunnel tests to investigate the aerodynamic characteristics and dynamic behavior of the MLLV SRM stages under laboratory conditions.

Test Description:

Force Model Tests - The purpose of these tests will be to ascertain range safety aerodynamics after inflight destruct, by checking the aerodynamic characteristics of models of selected fragments of the SRM stage.

MLLV/SRM stage Base Heating Model Tests - Supersonic and transonic tests will be conducted. The tests will include heating and pressure measurements in the base region of possible configurations and anticipated flight environments.

Performance Characteristics of Various Vehicle Combinations - Model tests will determine aerodynamic performance characteristics of possible vehicle configurations within the vehicle family.

Resource Requirements:

The assumption is that adequate facilities already exist for the conduct of the model tests to develop the required information for the MLLV program. It is anticipated, therefore, that costs for these tests will be based on procurement of the models and occupancy time at the test facility.

Based on prior test experience, the following estimate is shown in Table 4. 4. 8. 0-I.

TABLE 4.4.8.0-I
MLLV COST SUMMARY

WIND TUNNEL SRM STAGE

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & RA											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									400		400
TOTAL COST									400		400

MLLV
 DEVELOPMENTAL TESTING COSTS
 NON-RECURRING
WIND TUNNEL TEST SRM STAGE

TABLE 4.4.8.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Wind Tunnel Models	<u>400</u>

(1) These costs are based on Engineering Estimate.

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4.4.9 Structural Tests - SRM Stage

Structural tests for the SRM stage are defined as those tests that are required to prove the reliability of the following:

1. Attach structure
2. Aft skirt
3. Nose cone
4. Fittings

Table 4.4.9.0-I displays the costs that are associated with these tests. Additional costs are shown for test facilities, material dollars, and cost of conducting the tests. These tests apply to the Boeing built structures only.

TABLE 4.4.9.0-I

MLLV COST SUMMARY

STRUCTURAL TEST - SRM

A ☐ B ☒ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST			40	388						30	388
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR			40	388						40	388
MATERIAL				216							216
LOGISTIC HARDWARE				*2,922							2,922
BURDEN											
TOTAL MATERIAL				3,138							3,138
TOTAL OTHER				263							263
TOTAL COST				3,789							3,789

* TEST SPECIMEN

MLLV
SRM
* STRUCTURAL TEST
NON-RECURRING
(DOLLARS IN THOUSANDS)

TABLE 4.4.9.0-II

	<u>Manhours</u>	<u>Dollars</u>
Test Facilities		263
2. Test Specimen		
Attach Structure		1,465
Aft Skirt		451
Fittings		337
Nose Cone		669
3. Cost of Running Tests		
Labor	40,000	388
Material		216
	<hr/>	<hr/>
Total Cost	<u>40,000</u>	<u>3,789</u>

Tests to be conducted at Michoud, on the specimens mentioned above.
Test facilities are in addition to the facilities required for the
core stage vehicle.

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N70-11129

FINAL REPORT
FOR
COST STUDIES OF MULTIPURPOSE
LARGE LAUNCH VEHICLES

BASELINE MLLV COSTS

BOOK C OF VOLUME V

PREPARED UNDER CONTRACT NAS2-5056
FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF ADVANCE RESEARCH AND TECHNOLOGY
MISSION ANALYSIS DIVISION
SEPTEMBER 15, 1969

PREPARED BY



C.A. PENDER

J. LEE

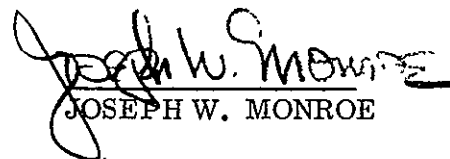
W. RICHARD

SUPERVISED BY



J. R. TURNEY

APPROVED BY



JOSEPH W. MONROE

THE BOEING COMPANY
SOUTHEAST DIVISION
HUNTSVILLE OPERATION
HUNTSVILLE, ALABAMA

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NOTE: This is the third book (Book C) of the three books which comprise Volume V, Baseline MLLV Cost, of the final documentation for "Cost Studies of Multipurpose Large Launch Vehicles". This book contains Section 5.0, MLLV First Unit or "C" Cost. Sections 1.0 through 3.0 are contained in Book A of Volume V. Included in Book A are the Introduction and Summary, Cost Ground Rules and Guidelines and the Get Ready or "A" costs. Section 4.0 presents the development test costs or "B" cost in Book B of Volume V.

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5.0 FIRST UNIT OR "C" COST

This section contains a detailed breakdown of the total recurring cost for the first unit of the configuration elements of the Multipurpose Large Launch Vehicle (MLLV) Baseline Family. The First Unit has been defined as the first article for flight test i.e., the first R&D flight test.

The recurring costs have been categorized into subparagraphs as follows:

- 5.1 Single Stage Vehicle (Section 5.1.0.0)
- 5.2 Engine Module - Injection Stage (Section 5.2.0.0)
- 5.3 Delta Costs for One (1) Fuel Module - Injection Stage (Section 5.3.0.0)
- 5.4 SRM Stage - Fixed Cost (Section 5.4.0.0)
- 5.5 SRM Stage - Variable Cost (Section 5.5.0.0)

For convenience and easy reference, the costs associated with the above items are displayed by major component, system and subsystem in Figure 5.0.0.0-1. Section numbers are referenced to assist in locating desired item(s).

As stated in Section 1.0 of this volume, (see Book A, Volume V), the output of Phase I, Task 1 was to produce "Modularized" cost data. The modularized data presented in this section provide an understanding of the costs associated with hardware production and utilization through launch and will enable the reader to evaluate the relative impact of specific items and/or elements on overall program costs. The first unit costs were developed in such a manner that the major vehicle configuration elements stand on their own i.e., the costs for the Single Stage Vehicle (Section 5.1) are the total costs for production and launch of a single-stage-to-orbit vehicle. The costs of the Injection Stage Engine Module (Section 5.2) are the additional costs for production and launch of that configuration element. The same holds true for the costs of the Injection Stage Fuel Module and the costs of the SRM stages.

The format for displaying cost information, for each component or system, consists of four major parts as follows:

- Part I Program Management, Program Planning and Reporting, and Industrial Relations.
- Part II Engineering, Production, Tooling, and Manufacturing Test.

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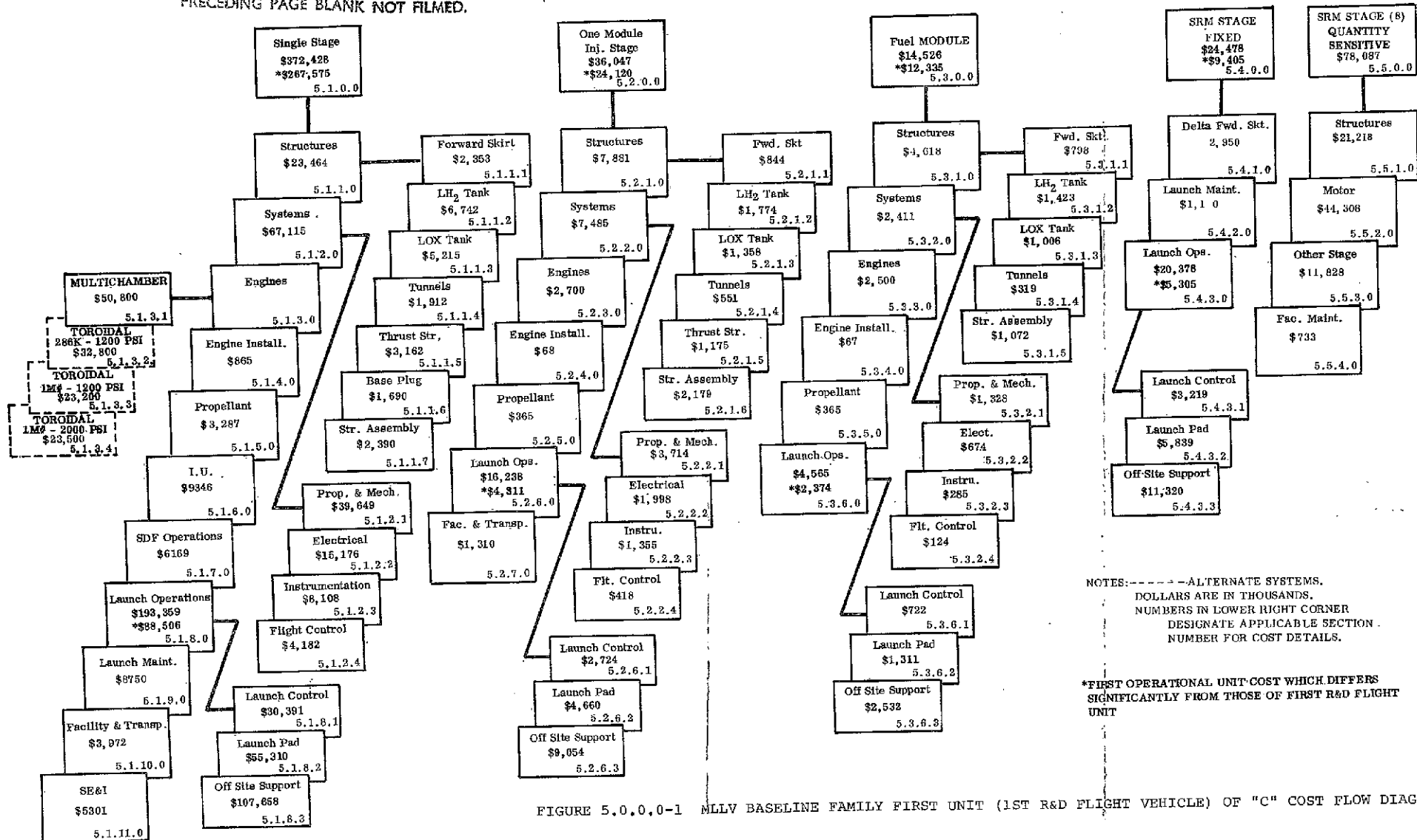


FIGURE 5.0.0.0-1 MLLV BASELINE FAMILY FIRST UNIT (1ST R&D FLIGHT VEHICLE) OF "C" COST FLOW DIAGRAM

5.0 (Continued)

Part III - Facilities.

Part IV - Logistics.

In addition, costs are displayed by element of cost, i.e., Engineering, Production, Test, Quality, etc. For an understanding of these elements, their makeup (direct input and/or factored), their base of application and in some instances their history, refer to Book A, Section 2.0 - Ground Rules and Assumptions.

The costs contained in this section are First Unit costs only. To determine the costs associated with any other unit and/or block of units, learning curves must be used.

Table 5.0.0.0-I shows the learning curve values for the Program Elements (i.e., Structures, Systems, Engines, etc.). These are divided into groups and are thereby defined by origin.

Table 5.0.0.0-II presents the method used to develop the composite learning curve used for the structure, systems, engine installation, and facilities and transportation. The learning curve values for the above vehicle components vary from 83% to 95%. These components were classified by engineering and management, manufacturing, quality, facilities and materials. The appropriate learning curve was applied to each of these cost categories to develop the weighted composite learning curve average of 91%.

TABLE 5.0.0.0-I MLLV COST ANALYSIS
 PHASE I TASK I
 DEVELOPMENT OF COMPOSITE LEARNING CURVE
 SINGLE STAGE VEHICLE

<u>Element</u>	<u>Learning Curve</u>	<u>Origin</u>
Structures	91%	See Table 5.0.0.0-II
Systems	91%	
Engine Installation	91%	
Facility and Transportation	91%	
Engines	95%	Per Engine Contractor
Propellant	100%	Assumed not to be Affected by Learning Curve
I. U.	100%	
SDF Operations	100%	
Launch Maintenance	100%	
SE&I	100%	
Launch Operations	100%	

TABLE 5.0.0.0-II MLLV COST ANALYSIS

DEVELOPMENT OF COMPOSITE LEARNING CURVE - SINGLE STAGE VEHICLE

		%	ENGR & MGT 95%	%	MFG 83%	%	QUAL & FAC 90%	%	MAT'L 98%	TOTAL
Engineering			4,430							
Lab Technicians			742							
Program Planning & Reporting			1,724							
Industrial Relations			289							
Program Executive			652							
Logistics Engineering			687							
Subtotal		9.0%	8,524							
Tooling					1,688					
Manufacturing Technicians					838					
Production (Inc Direct Distr. & Trng)					35,608					
Manufacturing Testing					1,299					
Subtotal				41.3%	39,433					
Q&RA							8,082			
Facilities							4,605			
Subtotal						13.3%	12,687			
Material									34,772	
Subtotal								36.4%	34,772	
Total										95,416*
95% X 9.0%		= 8.6%								
83% X 41.3%		= 34.3%								
90% X 13.3%		= 12.0%								
98% X 36.4%		<u>= 35.7%</u>								
Total Composite		90.6%								

* Includes structures, systems, engine installation, and facility and transportation.

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5.1 SINGLE STAGE VEHICLE

The summary costs for the first unit single stage MLLV vehicle are displayed in Figure 5.1.0.0-1. These costs include not only the cost of the hardware, but all the costs associated with launching the vehicle and maintaining the production and launch facilities. Table 5.1.0.0-I displays the total cost of a single stage vehicle by part and by element of cost for the first R&D flight vehicle. Table 5.1.0.0-II displays (for reference) the costs for the first operational vehicle (third unit).

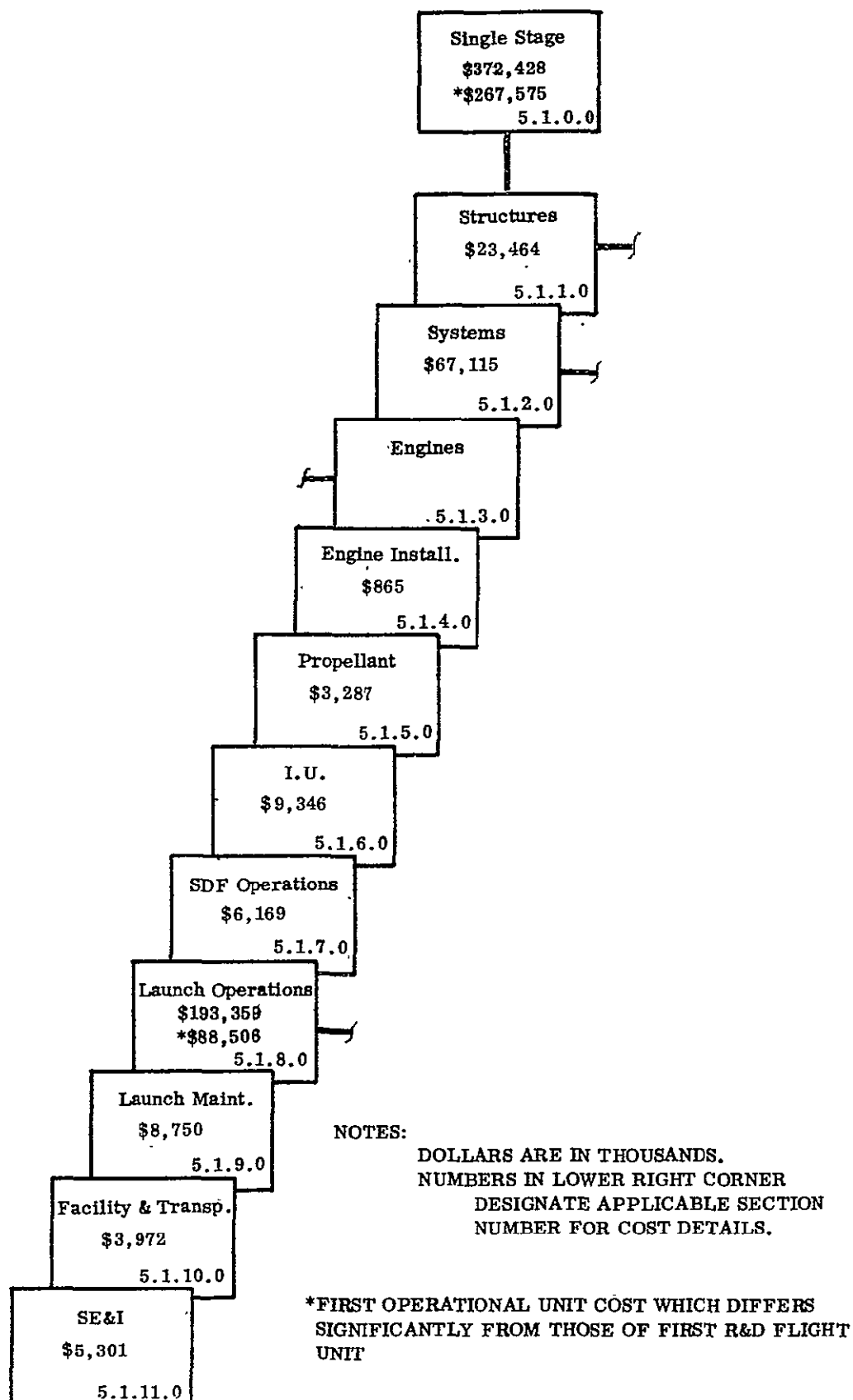


FIGURE 5.1.0.0-1 SINGLE STAGE VEHICLE COST FLOW DIAGRAM

S/S STAGE - 2 R&D FLIGHT VEHICLES

TABLE 5.1.0.0
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	235	2778								235	2,778
PROGRAM PLAN.& REPT.	580	6945								580	6,945
INDUSTRIAL RELATIONS	129	1256								129	1,256
ENGINEERING			1577	20946			58	687		1,635	21,633
LAB TECHNICIANS			75	742						75	742
TOOLING			174	5388						174	5,388
PRODUCTION			17559	212061						17,559	212,061
MANUFACTURING TEST			135	4599						135	4,599
MANUFACTURING TECH.			71	838						71	838
Q & R A			3653	35731						3,653	35,731
FACILITIES					63	13355				63	13,355
DIRECT DIST			794	7709						794	7,709
TRAINING			43	421						43	421
TOTAL DIRECT LABOR	944	10979	24081	288435	63	13355	58	687		25,146	313,456
MATERIAL		3		28890							28,893
LOGISTIC HARDWARE								2497			2,497
BURDEN				2828				651			3,479
TOTAL MATERIAL		3		31718				3148			34,869
TOTAL OTHER									24103		24,103
TOTAL COST		10982		320153		13355		3835	24103		372,428

SINGLE STAGE - OPERATIONAL VEHICLES
(THIRD VEHICLE AND SUBSEQUENT VEHICLES)

TABLE 5.1.0.0- II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	56	652								56	652
PROGRAM PLAN. & REPT.	138	1724								138	1,724
INDUSTRIAL RELATIONS	30	289								30	289
ENGINEERING			4978	50858			58	687		5,036	51,545
LAB TECHNICIANS			75	742						75	742
TOOLING			174	5388						174	5,388
PRODUCTION			8443	112845						8,443	112,845
MANUFACTURING TEST			135	4599						135	4,599
MANUFACTURING TECH.			71	838						71	838
Q & RA			808	8082						808	8,082
FACILITIES					63	13355				63	13,355
DIRECT DIST			794	7709						794	7,709
TRAINING			43	421						43	421
TOTAL DIRECT LABOR	224	2665	15521	191482	63	13355	58	687		15,866	208,189
MATERIAL		3		29328							29,331
LOGISTIC HARDWARE								2497			2,497
BURDEN				2804				651			3,455
TOTAL MATERIAL		3		32132				3148			35,283
TOTAL OTHER									24103		24,103
TOTAL COST		2668		223614		13355		3835	24103		267,575

5.1.1 Structures

The first R&D flight unit production cost for the structural components of the single stage vehicle are displayed in Figure 5.1.1.0-1. The cost details of the structural components are contained in appropriate subparagraphs, as indicated.

Table 5.1.1.0-I is a total cost summary of these structures.

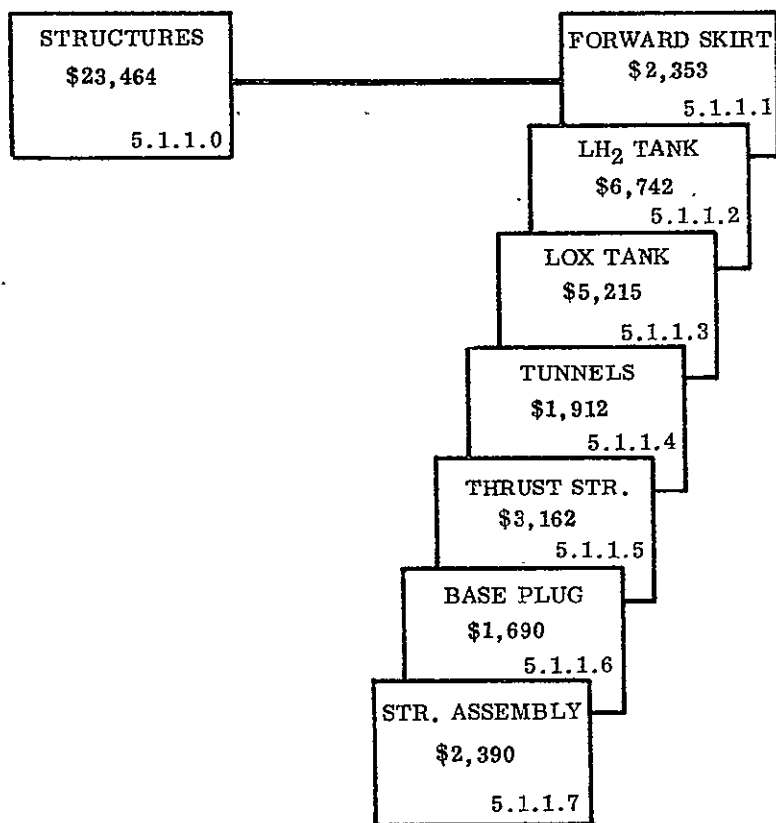
TOTAL STRUCTURE - SINGLE STAGE

TABLE 5.1.1.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	18	\$210								18	\$ 210
PROGRAM PLAN. & REPT.	46	619								46	619
INDUSTRIAL RELATIONS	9	93								9	93
ENGINEERING			209	\$ 2,460			31	\$ 372		240	2,832
LAB TECHNICIANS			41	406						41	406
TOOLING			52	494						52	494
PRODUCTION			828	8,047						828	8,047
MANUFACTURING TEST			38	373						38	373
MANUFACTURING TECH.			21	245						21	245
Q & R A			240	2,340						240	2,340
FACILITIES					17	186				17	186
DIRECT DIST			233	2,257						233	2,257
TRAINING			13	124						13	124
TOTAL DIRECT LABOR	73	\$922	1,675	\$16,746	17	\$186	31	\$ 372		1,796	18,226
MATERIAL				2,916							2,916
LOGISTIC HARDWARE								1,005			1,005
BURDEN				991				326			1,317
TOTAL MATERIAL				3,907		\$186		\$1,331			\$ 5,238
TOTAL OTHER											
TOTAL COST		\$922		\$20,653		\$186		\$1,703			\$23,464



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 5.1.1.0-1 SINGLE STAGE STRUCTURES COST FLOW DIAGRAM

5.1.1.1 Forward Skirt - Standard (Light Weight)

TABLE 5.1.1.1-I
MLLV COST SUMMARY

FORWARD SKIRT - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	24								2	24
PROGRAM PLAN. & REPT.	5	59								5	59
INDUSTRIAL RELATIONS	1	10								1	10
ENGINEERING			2	17				3		2	20
LAB TECHNICIANS				3							3
TOOLING			7	68						7	68
PRODUCTION			113	1,101						113	1,101
MANUFACTURING TEST			5	51						5	51
MANUFACTURING TECH.			3	33						3	33
Q & R A			32	310						32	310
FACILITIES					3	25				3	25
DIRECT DIST			32	309						32	309
TRAINING			2	17						2	17
TOTAL DIRECT LABOR	8	93	196	1,909	3	25		3		207	2,030
MATERIAL				226							226
LOGISTIC HARDWARE								15			15
BURDEN				77				5			82
TOTAL MATERIAL				303				20			323
TOTAL OTHER											
TOTAL COST		93		2,212		25		23			2,353

MLLV

PART I

FORWARD SKIRT - S/S
ASSEMBLY OR SYSTEM
 TABLE 5.1.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	1,738		
Logistics	262		
Laboratory Technician	348		
Production	113,283		
Tooling	6,958		
Manufacturing Test	5,272		
Q&RA	31,868		
Facilities	2,609		
Manufacturing Technician	<u>2,845</u>		
Total Direct Labor	<u>165,183</u>		
Program Executive		1,982	23,407
Program Planning & Reporting		4,955	58,519
Industrial Relations		<u>1,074</u>	<u>10,439</u>
Total Labor - Part I		<u>8,011</u>	<u>92,365</u>
<u>Material</u>			
Program Planning & Reporting			99
Industrial Relations			11
Material Subtotal			110
Material & Administrative Burden			<u>37</u>
Total Material			<u>147</u>
TOTAL COST - PART I			<u>92,512</u>

TABLE 5.1.1.1-III

FORWARD SKIRT - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒ (IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		MANUFACTURING TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	2	17							2	17
LAB TECHNICIANS		3								3
TOOLING					7	68			7	68
PRODUCTION			113	1,101					113	1,101
MANUFACTURING TEST							5	51	5	51
MANUFACTURING TECH.			3	32				1	3	33
Q&RA		1	28	277	2	18	1	14	31	310
DIRECT DIST			28	271	2	21	2	17	32	309
TRAINING			2	15		1		1	2	16
TOTAL DIRECT LABOR	2	21	74	1,696	11	108	8	84	195	1,909
MATERIAL										
LAB. TECHNICIANS		1								1
TOOLING						12				12
PRODUCTION				199						199
MFG. TECHNICIANS				5						5
Q&RA				8		1		1		10
SUBTOTAL		1		212		13		1		227
MAT. & ADM. BURDEN				72		4				76
TOTAL MATERIAL		1		284		17		1		303
TOTAL PART II COST		22		1,980		125		85		2,212

MLLV
PART II
ENGINEERING
FORWARD SKIRT - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	1,702	16,543
Reliability Engineering	<u>36</u>	<u>350</u>
(1) Subtotal (A)	1,738	16,893
(2) Laboratory Technicians	<u>348</u>	<u>3,383</u>
Subtotal (B)	2,086	20,276
(3) Q&RA	<u>70</u>	<u>680</u>
Total Engineering Labor	<u>2,156</u>	<u>20,956</u>
Material		
(4) Lab. Tech.		731
(5) Q&RA		<u>21</u>
Subtotal (C)		752
(6) Material & Adm. Burden		<u>256</u>
Total Material		<u>1,008</u>
Total Engineering Cost		<u>21,964</u>

MLIV
PART II
MANUFACTURING
PRODUCTION

FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>79,871</u>	\$ <u>776,346</u>
(2) Miscellaneous Charges	<u>6,230</u>	<u>60,556</u>
(3) Maintain & Add in Scope Changes	<u>879</u>	<u>8,544</u>
Subtotal	86,980	845,446
(4) Tool & Production Planning	<u>26,303</u>	<u>255,665</u>
Subtotal	113,283	1,101,111
(5) Direct Distributable	<u>27,834</u>	<u>270,546</u>
Subtotal	141,117	1,371,657
(6) Training	<u>1,552</u>	<u>15,085</u>
Subtotal	142,669	1,386,742
(7) Q&RA	<u>28,534</u>	<u>277,350</u>
(8) Mfg. Tech.	<u>2,711</u>	<u>32,017</u>
Total Production Labor	<u>173,914</u>	<u>\$1,696,109</u>
Material		
(9) Raw Material & Standards		\$ <u>198,913</u>
(10) Q&RA		<u>8,560</u>
(11) Mfg. Tech.		<u>4,744</u>
Material Subtotal		\$ 212,217
(12) Material & Adm. Burden		<u>72,154</u>
Total Material		<u>\$ 284,371</u>
Total Production Cost		<u>\$1,980,480</u>

MLIV
PART II
MANUFACTURING
TOOLING

FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>6,958</u>	<u>\$ 67,631</u>
(2) Direct Distributable	<u>2,227</u>	<u>21,642</u>
Subtotal	<u>9,185</u>	<u>89,273</u>
(3) Training	<u>101</u>	<u>982</u>
Subtotal	<u>9,286</u>	<u>90,255</u>
(4) Q&RA	<u>1,857</u>	<u>18,051</u>
Total Tooling Labor	<u><u>11,143</u></u>	<u><u>\$ 108,306</u></u>
Material		
(5) Tooling		<u>\$ 12,177</u>
(6) Q&RA		<u>557</u>
Subtotal		<u>12,734</u>
(7) Material & Adm. Burden		<u>4,329</u>
Total Material		<u><u>17,063</u></u>
Total Tooling Cost		<u><u>\$ 125,369</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
FORWARD SKIRT - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.1.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	3,994	38,821
Component Test Planning	<u>1,278</u>	<u>12,422</u>
(1) Subtotal (A)	5,272	51,244
(2) Direct Distributable	<u>1,687</u>	<u>16,398</u>
Subtotal (B)	6,959	67,641
(3) Training	<u>77</u>	<u>744</u>
Subtotal (C)	7,036	68,385
(4) Mfg. Tech.	<u>134</u>	<u>1,578</u>
Subtotal (D)	7,169	69,963
(5) Q&RA	<u>1,407</u>	<u>13,677</u>
Total Mfg. Test Labor	<u>8,576</u>	<u>83,640</u>
Material		
(6) Q&RA		422
(7) Mfg. Tech.		<u>234</u>
Subtotal (E)		656
(8) Material & Adm. Burden		<u>223</u>
Total Material		<u>879</u>
Total Mfg. Test Cost		<u>84,519</u>

MLLV
PART III
FACILITY LABOR

FORWARD SKIRT - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	2,609	\$25,359
TOTAL FACILITY LABOR COST	<u>2,609</u>	<u>\$25,359</u>

MLLV
PART IV
LOGISTIC LABOR

FORWARD SKIRT - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>262</u>	<u>\$ 3,094</u>
(2) Hardware	<u> </u>	<u>14,672</u>
(3) Material & Adm. Burden	<u> </u>	<u>4,988</u>
Total Material	<u> </u>	<u>\$19,660</u>
Total Logistic Cost	<u> </u>	<u>\$22,754</u>

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5.1.1.2 LH₂ Tank

TABLE 5.1.1.2-I
MLLV COST SUMMARY

LH₂ TANK - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	52								5	52
PROGRAM PLAN. & REPT.	11	129								11	129
INDUSTRIAL RELATIONS	2	23								2	23
ENGINEERING			22	257			3	39		25	296
LAB TECHNICIANS			4	42						4	42
TOOLING			14	139						14	139
PRODUCTION			233	2,263						233	2,263
MANUFACTURING TEST			11	105						11	105
MANUFACTURING TECH.			6	69						6	69
Q & R A			66	644						66	644
FACILITIES					5	52				5	52
DIRECT DIST			65	634						65	634
TRAINING			4	35						4	35
TOTAL DIRECT LABOR	18	204	425	4,188	5	52	3	39		451	4,483
MATERIAL				1,514							1,514
LOGISTIC HARDWARE								183			183
BURDEN				515				47			562
TOTAL MATERIAL				2,029				230			2,259
TOTAL OTHER											
TOTAL COST		204		6,217		52		269			6,742

MLLV
LH₂ TANK
PART I

TABLE 5.1.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	21,725		
Logistics	3,275		
Laboratory Technician	4,345		
Production	232,795		
Tooling	14,299		
Manufacturing Test	10,833		
Q&RA	66,212		
Facilities	5,362		
Manufacturing Technician	<u>5,845</u>		
Total Direct Labor	<u>364,691</u>		
Program Executive		4,376	51,681
Program Planning & Reporting		10,941	129,213
Industrial Relations		<u>2,370</u>	<u>23,036</u>
Total Labor - Part I		<u>17,687</u>	<u>203,930</u>
<u>Material</u>			
Program Planning & Reporting			219
Industrial Relations			24
Material Subtotal			243
Material & Administrative Burden			<u>83</u>
Total Material			<u>326</u>
TOTAL COST - PART I			<u>204,256</u>

TABLE 5.1.1.2-III

LH₂ TANK - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	22	257							22	257
LAB TECHNICIANS	4	42							4	42
TOOLING					14	139			14	139
PRODUCTION			233	2263					233	2263
MANUFACTURING TEST							11	105	11	105
MANUFACTURING TECH.			5	66				3	5	69
Q & R A	1	8	59	570	4	37	3	28	67	643
DIRECT DIST			57	556	5	44	3	34	65	634
TRAINING			3	31		2		2	3	35
TOTAL DIRECT LABOR	27	307	357	3485	23	223	17	172	424	4187
MATERIAL										
LAB. TECHNICIANS		9								9
TOOLING						25				25
PRODUCTION				1450						1450
MFG. TECHNICIANS				10						10
Q & R A				18		1		1		20
SUBTOTAL		9		1478		26		1		1514
MAT. & ADM. BURDEN		3		502		9		1		515
TOTAL MATERIAL		12		1980		35		2		2029
TOTAL PART II COST		319		5465		258		174		6216

MLLV
PART II
ENGINEERING
LH₂ TANK - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	21,275	\$251,258
Reliability Engineering	<u>450</u>	<u>5,314</u>
(1) Subtotal (A)	21,725	\$256,572
(2) Laboratory Technicians	<u>4,345</u>	<u>42,233</u>
Subtotal (B)	26,070	\$298,805
(3) Q&RA	<u>869</u>	<u>8,447</u>
Total Engineering Labor	<u>26,939</u>	<u>\$307,252</u>
Material		
(4) Lab. Tech.		\$ 9,125
(5) Q&RA		<u>261</u>
Subtotal (C)		\$ 9,386
(6) Material & Adm. Burden		<u>3,191</u>
Total Material		<u>\$ 12,577</u>
Total Engineering Cost		<u>\$319,829</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

LH₂ TANK - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>164,135</u>	<u>\$1,595,392</u>
(2) Miscellaneous Charges	<u>12,803</u>	<u>124,440</u>
(3) Maintain & Add in Scope Changes	<u>1,805</u>	<u>17,548</u>
Subtotal	178,743	\$1,737,381
(4) Tool & Production Planning	<u>54,052</u>	<u>525,383</u>
Subtotal	232,795	\$2,262,764
(5) Direct Distributable	<u>57,198</u>	<u>555,962</u>
Subtotal	289,992	\$2,818,726
(6) Training	<u>3,190</u>	<u>31,006</u>
Subtotal	293,182	2,849,732
(7) Q&RA	<u>58,636</u>	<u>569,946</u>
(8) Mfg. Tech.	<u>5,570</u>	<u>65,786</u>
Total Production Labor	<u>357,389</u>	<u>\$3,485,464</u>
Material		
(9) Raw Material & Standards		<u>\$1,450,000</u>
(10) Q&RA		<u>17,591</u>
(11) Mfg. Tech.		<u>9,748</u>
Material Subtotal		\$1,477,339
(12) Material & Adm. Burden.		<u>502,295</u>
Total Material		<u>\$1,979,634</u>
Total Production Cost		<u>\$5,465,098</u>

MLLV
PART II
MANUFACTURING
TOOLING

LH₂ TANK - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>14,299</u>	<u>\$ 138,986</u>
(2) Direct Distributable	<u>4,576</u>	<u>44,475</u>
Subtotal	<u>18,875</u>	<u>183,461</u>
(3) Training	<u>208</u>	<u>2,018</u>
Subtotal	<u>19,082</u>	<u>185,479</u>
(4) Q&RA	<u>3,816</u>	<u>37,095</u>
Total Tooling Labor	<u><u>22,898</u></u>	<u><u>\$ 222,574</u></u>
Material		
(5) Tooling		<u>\$ 25,023</u>
(6) Q&RA		<u>1,145</u>
Subtotal		<u>26,168</u>
(7) Material & Adm. Burden		<u>8,897</u>
Total Material		<u><u>35,065</u></u>
Total Tooling Cost		<u><u>\$ 257,639</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
LH₂ TANK- S/S
TABLE 5.1.1.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	8,207	79,772
Component Test Planning	2,626	25,527
Subtotal	<u>10,833</u>	<u>105,299</u>
Direct Distributable	3,467	33,695
Subtotal	<u>14,300</u>	<u>138,994</u>
Training	157	1,528
Subtotal	<u>14,457</u>	<u>140,522</u>
Mfg. Tech.	275	3,243
Subtotal	<u>14,732</u>	<u>143,765</u>
Q&RA	2,891	28,104
Total Mfg. Test Labor	<u>17,623</u>	<u>171,869</u>
Material		
Q&RA		867
Mfg. Tech.		481
Subtotal		<u>1,348</u>
Material & Adm. Burden		458
Total Material		<u>1,806</u>
Total Mfg. Test Cost		<u>173,675</u>

MLLV
PART III
FACILITY LABOR

LH₂ TANK - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.1.2-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	5,362	\$52,119
TOTAL FACILITY LABOR COST	<u>5,362</u>	<u>\$52,119</u>

MLLV

PART IV
LOGISTIC LABOR

LH₂ TANK - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.1.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>3,275</u>	<u>\$ 38,678</u>
(2) Hardware		183,400
(3) Material & Adm. Burden		<u>47,056</u>
Total Material		<u>\$230,456</u>
Total Logistic Cost		<u>\$269,134</u>

5.1.1.3 LOX Tank

TABLE 5.1.1.3-1
MLLV COST SUMMARY

LOX TANK - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	47								4	47
PROGRAM PLAN. & REPT.	10	116								10	116
INDUSTRIAL RELATIONS	2	21								2	21
ENGINEERING			39	462			6	70		45	532
LAB TECHNICIANS			8	76						8	76
TOOLING			12	114						12	114
PRODUCTION			191	1,858						191	1,858
MANUFACTURING TEST			9	86						9	86
MANUFACTURING TECH.			5	57						5	57
Q & R A			55	537						55	537
FACILITIES					4	43				4	43
DIRECT DIST			54	521						54	521
TRAINING			3	28						3	28
TOTAL DIRECT LABOR	16	184	376	3,739	4	43	6	70		402	4,036
MATERIAL				550							550
LOGISTIC HARDWARE								330			330
BURDEN				187				112			299
TOTAL MATERIAL				737				442			1,179
TOTAL OTHER											
TOTAL COST		184		4,476		43		512			5,215

MLLV

PART. I

LOX TANK
ASSEMBLY OR SYSTEM
 TABLE 5.1.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	39,105		
Logistics	5,895		
Laboratory Technician	7,821		
Production	191,130		
Tooling	11,740		
Manufacturing Test	8,894		
Q&RA	55,213		
Facilities	4,403		
Manufacturing Technician	<u>4,799</u>		
Total Direct Labor	<u>329,000</u>		
Program Executive		3,948	\$ 46,626
Program Planning & Reporting		9,870	116,565
Industrial Relations		<u>2,139</u>	<u>20,791</u>
Total Labor - Part I		<u>15,957</u>	<u>\$183,982</u>
<u>Material</u>			
Program Planning & Reporting			197
Industrial Relations			21
Material Subtotal			218
Material & Administrative Burden			<u>74</u>
Total Material			<u>292</u>
TOTAL COST - PART I			<u>\$184,274</u>

TABLE 5.1.1.3-III

LOX TANK - S/S

MLIV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	39	462							39	462
LAB TECHNICIANS	8	76							8	76
TOOLING					12	114			12	114
PRODUCTION			191	1858					191	1858
MANUFACTURING TEST							9	86	9	86
MANUFACTURING TECH.			5	54				3	5	57
Q & R A	2	15	48	468	3	30	2	23	55	536
DIRECT DIST			47	457	4	37	3	28	54	522
TRAINING			3	25		2		1	3	28
TOTAL DIRECT LABOR	48	553	294	2862	19	183	14	141	375	3739
MATERIAL										
LAB. TECHNICIANS		16								16
TOOLING						21				21
PRODUCTION				488						488
MFG. TECHNICIANS				8						8
Q & R A		1		14		1		1		17
SUBTOTAL		17		510		22		1		550
MAT. & ADM. BURDEN		6		174		7				187
TOTAL MATERIAL		23		684		29		1		737
TOTAL PART II COST		576		3546		212		142		4476

MLLV
PART II
ENGINEERING

LOX TANK - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	38,295	\$452,264
Reliability Engineering	810	9,566
(1) Subtotal (A)	39,105	461,830
(2) Laboratory Technicians	7,821	76,020
Subtotal (B)	46,926	537,850
(3) Q&RA	1,564	15,201
Total Engineering Labor	48,490	553,051
Material		
(4) Lab. Tech.		16,424
(5) Q&RA		469
Subtotal (C)		16,893
(6) Material & Adm. Burden		5,744
Total Material		22,637
Total Engineering Cost		\$ 575,688

MLIV
PART II
MANUFACTURING
PRODUCTION

LOX TANK - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.1.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>134,759</u>	<u>\$1,309,857</u>
(2) Miscellaneous Charges	<u>10,511</u>	<u>102,169</u>
(3) Maintain & Add in Scope Changes	<u>1,482</u>	<u>14,408</u>
Subtotal	146,753	\$1,426,434
(4) Tool & Production Planning	<u>44,378</u>	<u>431,353</u>
Subtotal	191,130	1,857,787
(5) Direct Distributable	<u>46,961</u>	<u>456,459</u>
Subtotal	238,091	2,314,246
(6) Training	<u>2,619</u>	<u>25,457</u>
Subtotal	240,710	2,339,703
(7) Q&RA	<u>48,142</u>	<u>467,940</u>
(8) Mfg. Tech.	<u>4,573</u>	<u>54,012</u>
Total Production Labor	<u>293,426</u>	<u>\$2,861,655</u>
Material		
(9) Raw Material & Standards		\$ 488,000
(10) Q&RA		<u>14,443</u>
(11) Mfg. Tech.		<u>8,003</u>
Material Subtotal		\$ 510,446
(12) Material & Adm. Burden		<u>173,552</u>
Total Material		<u>\$ 683,998</u>
Total Production Cost		<u>\$3,545,653</u>

MLIV
PART II
MANUFACTURING.
TOOLING

LOX TANK - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	11,740	\$ 114,113
(2) Direct Distributable	<u>3,757</u>	<u>36,516</u>
Subtotal	15,497	150,629
(3) Training	<u>170</u>	<u>1,656</u>
Subtotal	15,667	152,285
(4) Q&RA	<u>3,133</u>	<u>30,457</u>
Total Tooling Labor	<u>18,800</u>	<u>\$ 182,742</u>
Material		
(5) Tooling		\$ 20,545
(6) Q&RA		<u>940</u>
Subtotal		21,485
(7) Material & Adm. Burden		<u>7,305</u>
Total Material		<u>28,790</u>
Total Tooling Cost		<u>\$ 211,532</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

LOX TANK - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

<u>Element of Cost</u>	TABLE 5.1.1.3-VII	<u>Manhours</u>	<u>Dollars</u>
Component Test		6,738	65,493
Component Test Planning		2,156	20,957
Subtotal		8,894	86,450
Direct Distributable		2,846	27,664
Subtotal		11,740	114,114
Training		129	1,255
Subtotal		11,869	115,369
Mfg. Tech.		226	2,663
Subtotal		12,095	118,032
Q&RA		2,374	23,073
Total Mfg. Test Labor		14,469	141,105
Material			
Q&RA			712
Mfg. Tech			395
Subtotal			1,107
Material & Adm. Burden			376
Total Material			1,483
Total Mfg. Test Cost			142,588

MLLV
PART III
FACILITY LABOR

LOX TANK - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	4,403	\$42,797
TOTAL FACILITY LABOR COST	<u>4,403</u>	<u>\$42,797</u>

MLLV
PART IV
LOGISTIC LABOR

LOX TANK - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>5,895</u>	<u>\$ 69,620</u>
(2) Hardware		330,120
(3) Material & Adm. Burden		<u>112,241</u>
Total Material		<u>\$442,361</u>
Total Logistic Cost		<u>\$511,981</u>

5.1.1.4 Tunnels

TUNNELS

TABLE 5.1.1.4-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	16								1	16
PROGRAM PLAN. & REPT.	4	41								4	41
INDUSTRIAL RELATIONS	1	7								1	7
ENGINEERING			16	185			2	28		18	213
LAB TECHNICIANS			3	31						3	31
TOOLING			4	39						4	39
PRODUCTION			66	639						66	639
MANUFACTURING TEST			3	30						3	30
MANUFACTURING TECH.			2	19						2	19
Q & R A			19	185						19	185
FACILITIES						15					15
DIRECT DIST			19	179						19	179
TRAINING				10							10
TOTAL DIRECT LABOR	6	64	132	1,317		15	2	28		140	1,424
MATERIAL				232							232
LOGISTIC HARDWARE								132			132
BURDEN				79				45			124
TOTAL MATERIAL				311				177			488
TOTAL OTHER											
TOTAL COST		64		1,628		15		205			1,912

MLLV
TUNNELS
PART I

TABLE 5.1.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	15,642		
Logistics	2,358		
Laboratory Technician	3,128		
Production	65,744		
Tooling	4,038		
Manufacturing Test	3,060		
Q&RA	19,081		
Facilities	154		
Manufacturing Technician	1,651		
Total Direct Labor	<u>114,856</u>		
Program Executive		1,378	16,274
Program Planning & Reporting		3,446	40,697
Industrial Relations		747	7,261
Total Labor - Part I		<u>5,571</u>	<u>64,232</u>
<u>Material</u>			
Program Planning & Reporting			69
Industrial Relations			7
Material Subtotal			76
Material & Administrative Burden			26
Total Material			<u>102</u>
TOTAL COST - PART I			<u>64,334</u>

TUNNELS - S/S

TABLE 5.1.1.4-III

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	15	185							15	185
LAB TECHNICIANS	3	30							3	30
TOOLING					4	39			4	39
PRODUCTION			66	639					66	639
MANUFACTURING TEST							3	30	3	30
MANUFACTURING TECH.			2	18				1	2	19
Q & R A	1	6	17	161	1	10	1	8	20	185
DIRECT DIST			16	157	1	13	1	10	18	180
TRAINING			1	9		1			1	10
TOTAL DIRECT LABOR	19	221	101	984	6	63	5	49	131	1317
MATERIAL										
LAB. TECHNICIANS		7								7
TOOLING						7				7
PRODUCTION				210						210
MFG. TECHNICIANS				3						3
Q & R A				5						5
SUBTOTAL		7		218		7				232
MAT. & ADM. BURDEN		2		74		3				79
TOTAL MATERIAL		9		292		10				311
TOTAL PART II COST		230		1276		73		49		1628

MLLV
PART IIA
ENGINEERING
TUNNELS - S/S

ASSEMBLY OR SYSTEM
TABLE 5.1.1.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	15,318	180,906
Reliability Engineering	324	3,826
(1) Subtotal (A)	15,642	184,732
(2) Laboratory Technicians	3,128	30,404
Subtotal (B)	18,770	215,136
(3) Q&RA	626	6,085
Total Engineering Labor	19,396	221,221
Material		
(4) Lab. Tech.		6,569
(5) Q&RA		188
Subtotal (C)		6,757
(6) Material & Adm. Burden		2,297
Total Material		9,054
Total Engineering Cost		\$ 230,275

MLLV
PART II
MANUFACTURING
PRODUCTION

TUNNELS - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>46,354</u>	\$ <u>450,561</u>
(2) Miscellaneous Charges	<u>3,616</u>	<u>35,144</u>
(3) Maintain & Add in Scope Changes	<u>510</u>	<u>4,955</u>
Subtotal	50,479	490,660
(4) Tool & Production Planning	<u>15,265</u>	<u>148,375</u>
Subtotal	65,744	639,034
(5) Direct Distributable	<u>16,153</u>	<u>157,011</u>
Subtotal	81,898	796,045
(6) Training	<u>901</u>	<u>8,756</u>
Subtotal	82,799	804,801
(7) Q&RA	<u>16,560</u>	<u>160,960</u>
(8) Mfg. Tech.	<u>1,573</u>	<u>18,578</u>
Total Production Labor	<u>100,931</u>	\$ <u>984,340</u>
Material		
(9) Raw Material & Standards		\$ <u>210,000</u>
(10) Q&RA		<u>4,968</u>
(11) Mfg. Tech.		<u>2,753</u>
Material Subtotal		\$ 217,721
(12) Material & Adm. Burden		<u>74,025</u>
Total Material		\$ <u>291,746</u>
Total Production Cost		<u>\$1,276,086</u>

MLLV
PART II
MANUFACTURING
TOOLING

TUNNELS - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	4,038	\$ 39,249
(2) Direct Distributable	1,292	12,559
Subtotal	5,330	51,808
(3) Training	59	570
Subtotal	5,389	52,378
(4) Q&RA	1,078	10,475
Total Tooling Labor	6,467	\$ 62,853
Material		
(5) Tooling		\$ 7,067
(6) Q&RA		323
Subtotal		7,390
(7) Material & Adm. Burden		2,513
Total Material		9,903
Total Tooling Cost		\$ 72,756

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
TUNNELS - S/S
TABLE 5.1.1.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	2,318	22,531
Component Test Planning	742	7,209
Subtotal	<u>3,060</u>	<u>29,740</u>
Direct Distributable	979	9,517
Subtotal	<u>4,039</u>	<u>39,257</u>
Training	44	432
Subtotal	<u>4,083</u>	<u>39,689</u>
Mfg. Tech.	78	915
Subtotal	<u>4,161</u>	<u>40,604</u>
Q&RA	817	7,937
Total Mfg. Test Labor	<u>4,978</u>	<u>48,541</u>
Material		
Q&RA		245
Mfg. Tech.		136
Subtotal		<u>381</u>
Material & Adm. Burden		129
Total Material		<u>510</u>
Total Mfg. Test Cost		<u>49,051</u>

MLLV
PART III
FACILITY LABOR

TUNNEL - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	154	\$14,716
TOTAL FACILITY LABOR COST	<u>154</u>	<u>\$14,716</u>

MLLV
 PART IV
 LOGISTIC LABOR
 TUNNELS - S/S
 ASSEMBLY OR SYSTEM
 TABLE 5.1.1.4-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>2,358</u>	\$ <u>27,848</u>
(2) Hardware		132,048
(3) Material & Adm. Burden		<u>44,896</u>
Total Material		<u>176,944</u>
Total Logistic Cost		<u>\$204,792</u>

5.1.1.5 Thrust Structure

THRUST STRUCTURE

TABLE 5.1.1.5-I
MLLV COST SUMMARY

A ☐ B ☐ C ☐

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	31								3	31
PROGRAM PLAN. & REPT.	7	172								7	172
INDUSTRIAL RELATIONS	1	14								1	14
ENGINEERING			15	174			2	27		17	201
LAB TECHNICIANS			3	29						3	29
TOOLING			9	82						9	82
PRODUCTION			138	1,340						138	1,340
MANUFACTURING TEST			6	62						6	62
MANUFACTURING TECH.			3	41						3	41
Q & R A			39	382						39	382
FACILITIES					3	31				3	31
DIRECT DIST			39	376						39	376
TRAINING			2	21						2	21
TOTAL DIRECT LABOR	11	217	254	2,507	3	31	2	27		270	2,782
MATERIAL				159							159
LOGISTIC HARDWARE								125			125
BURDEN				54				42			96
TOTAL MATERIAL				213				167			380
TOTAL OTHER											
TOTAL COST		217		2,720		31		194			3,162

MLLV

PART I

THRUST STRUCTURE
ASSEMBLY OR SYSTEM

TABLE 5.1.1.5-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	14,773		
Logistics	2,227		
Laboratory Technician	2,955		
Production	137,891		
Tooling	8,470		
Manufacturing Test	6,417		
Q&RA	39,305		
Facilities	3,176		
Manufacturing Technician	<u>3,463</u>		
Total Direct Labor	<u>218,677</u>		
Program Executive		2,624	30,989
Program Planning & Reporting		6,650	172,134
Industrial Relations		<u>1,421</u>	<u>13,812</u>
Total Labor - Part I		<u>10,605</u>	<u>216,935</u>
<u>Material</u>			
Program Planning & Reporting			131
Industrial Relations			14
Material Subtotal			145
Material & Administrative Burden			<u>49</u>
Total Material			<u>194</u>
TOTAL COST - PART I			<u>217,129</u>

TABLE 5.1.1.5-III
MLIV PART II COST SUMMARY

THRUST STRUCTURE - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	14	174							14	174
LAB TECHNICIANS	3	29							3	29
TOOLING					8	82			8	82
PRODUCTION			138	1340					138	1340
MANUFACTURING TEST							6	62	6	62
MANUFACTURING TECH.			3	39				2	3	41
Q & R A	1	6	35	338	2	22	2	17	40	383
DIRECT DIST.			34	330	3	27	2	20	39	377
TRAINING			2	18		1		1	2	20
TOTAL DIRECT LABOR	18	209	212	2065	13	132	10	102	253	2508
MATERIAL										
LAB. TECHNICIANS		6								6
TOOLING						15				15
PRODUCTION				120						120
MFG. TECHNICIANS				6						6
Q & R A				10		1		1		12
SUBTOTAL		6		136		16		1		159
MAT. & ADM. BURDEN		2		46		5				53
TOTAL MATERIAL		8		182		21		1		212
TOTAL PART II COST		217		2247		153		103		2720

MLLV
 PART II
 ENGINEERING
THRUST STRUCTURE - S/S
 ASSEMBLY OR SYSTEM
 TABLE 5.1.1.5-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	14,467	\$ 170,855
Reliability Engineering	<u>306</u>	<u>3,614</u>
(1) Subtotal (A)	14,773	174,469
(2) Laboratory Technicians	<u>2,955</u>	<u>28,723</u>
Subtotal (B)	17,728	203,192
(3) Q&RA	<u>599</u>	<u>5,822</u>
Total Engineering Labor	<u>18,327</u>	<u>\$209,014</u>
Material		
(4) Lab. Tech.		\$ 6,206
(5) Q&RA		<u>180</u>
Subtotal (C)		<u>6,386</u>
(6) Material & Adm. Burden		\$ 2,171
Total Material		<u>8,557</u>
Total Engineering Cost		<u>\$ 217,571</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

THRUST STRUCTURE - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.5-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>97,222</u>	\$ <u>944,998</u>
(2) Miscellaneous Charges	<u>7,583</u>	<u>73,710</u>
(3) Maintain & Add in Scope Changes	<u>1,069</u>	<u>10,395</u>
Subtotal	105,875	1,029,102
(4) Tool & Production Planning	<u>32,017</u>	<u>311,200</u>
Subtotal	137,891	1,340,302
(5) Direct Distributable	<u>33,880</u>	<u>329,313</u>
Subtotal	171,771	1,669,615
(6) Training	<u>1,889</u>	<u>18,365</u>
Subtotal	173,661	\$1,687,980
(7) Q&RA	<u>34,732</u>	<u>337,596</u>
(8) Mfg. Tech.	<u>3,300</u>	<u>38,967</u>
Total Production Labor	<u>211,692</u>	<u>\$2,064,543</u>
Material		
(9) Raw Material & Standards		\$ <u>120,000</u>
(10) Q&RA		<u>10,420</u>
(11) Mfg. Tech.		<u>5,774</u>
Material Subtotal		\$ 136,194
(12) Material & Adm. Burden		<u>46,306</u>
Total Material		\$ <u>182,500</u>
Total Production Cost		<u>\$2,247,043</u>

MLLV
PART II
MANUFACTURING
TOOLING

THRUST STRUCTURE - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.1.5-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	8,470	\$ 82,328
(2) Direct Distributable	2,710	26,345
Subtotal	11,180	108,673
(3) Training	123	1,195
Subtotal	11,303	109,868
(4) Q&RA	2,261	21,973
Total Tooling Labor	<u>13,564</u>	<u>\$ 131,841</u>
Material		
(5) Tooling		\$ 14,823
(6) Q&RA		678
Subtotal		15,501
(7) Material & Adm. Burden		5,270
Total Material		<u>20,771</u>
Total Tooling Cost		<u>\$ 152,612</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

THRUST STRUCTURE - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

<u>Element of Cost</u>	TABLE 5.1.1.5-VII	<u>Manhours</u>	<u>Dollars</u>
Component Test		4,861	47,249
Component Test Planning		<u>1,556</u>	<u>15,119</u>
Subtotal		6,417	62,368
Direct Distributable		<u>2,053</u>	<u>19,957</u>
Subtotal		8,470	82,325
Training		<u>93</u>	<u>905</u>
Subtotal		8,563	83,230
Mfg. Tech.		<u>163</u>	<u>1,920</u>
Subtotal		8,726	85,150
Q&RA		<u>1,713</u>	<u>16,646</u>
Total Mfg. Test Labor		<u>10,439</u>	<u>101,796</u>
Material			
Q&RA			514
Mfg. Tech.			<u>285</u>
Subtotal			799
Material & Adm. Burden			<u>271</u>
Total Material			<u>1,070</u>
Total Mfg. Test Cost			<u>102,866</u>

MLLV
PART III
FACILITY LABOR

THRUST STRUCTURE - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.5-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	3,176	\$30,871
TOTAL FACILITY LABOR COST	<u>3,176</u>	<u>\$30,871</u>

MLLV
PART IV
LOGISTIC LABOR

THRUST STRUCTURE - S/S
ASSEMBLY OR SYSTEM

TABLE 5.1.1.5-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>2,227</u>	\$ <u>26,301</u>
(2) Hardware		124,712
(3) Material & Adm. Burden		<u>42,402</u>
Total Material		<u>167,114</u>
Total Logistic Cost		\$ <u>193,415</u>

5.1.1.6 Base Plug

BASE PLUG - S/S

TABLE 5.1.1.6-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	13								1	13
PROGRAM PLAN. & REPT.	3	34								3	34
INDUSTRIAL RELATIONS	1	6								1	6
ENGINEERING			26	308			4	46		30	354
LAB TECHNICIANS			5	51						5	51
TOOLING			3	24						3	24
PRODUCTION			40	391						40	391
MANUFACTURING TEST			2	18						2	18
MANUFACTURING TECH.			1	12						1	12
Q & R A			12	120						12	120
FACILITIES					1	9				1	9
DIRECT DIST			11	110						11	110
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	5	53	101	1,040	1	9	4	46		111	1,148
MATERIAL				185							185
LOGISTIC HARDWARE								220			220
BURDEN				62				75			137
TOTAL MATERIAL				247				295			542
TOTAL OTHER											
TOTAL COST		53		1,287		9		341			1,690

MLLV

PART I

BASE PLUG
ASSEMBLY OR SYSTEM

TABLE 5.1.1.6-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	26,070		
Logistics	3,930		
Laboratory Technician	5,214		
Production	40,272		
Tooling	2,474		
Manufacturing Test	1,874		
Q&RA	12,347		
Facilities	928		
Manufacturing Technician	<u>1,012</u>		
Total Direct Labor	<u>94,121</u>		
Program Executive		1,129	13,333
Program Planning & Reporting		2,824	33,351
Industrial Relations		<u>612</u>	<u>5,949</u>
Total Labor - Part I		<u>4,565</u>	<u>52,633</u>
<u>Material</u>			
Program Planning & Reporting			56
Industrial Relations			6
Material Subtotal			62
Material & Administrative Burden			<u>21</u>
Total Material			<u>83</u>
TOTAL COST - PART I			<u>52,716</u>

TABLE 5.1.1.6-III

BASE PLUG - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	26	308							26	308
LAB TECHNICIANS	5	51							5	51
TOOLING					2	24			2	24
PRODUCTION			40	392					40	392
MANUFACTURING TEST							2	18	2	18
MANUFACTURING TECH.			1	11				1	1	12
Q & R A	1	10	10	99	1	6	1	5	13	120
DIRECT DIST			10	96	1	8	1	6	12	110
TRAINING			1	5		1			1	6
TOTAL DIRECT LABOR	32	369	62	603	4	39	4	30	102	1041
MATERIAL										
LAB. TECHNICIANS		11								11
TOOLING						4				4
PRODUCTION				164						164
MFG. TECHNICIANS				2						2
Q & R A				3		1				4
SUBTOTAL		11		169		5				185
MAT. & ADM. BURDEN		4		57		1				62
TOTAL MATERIAL		15		226		6				247
TOTAL PART II COST		384		829		45		30		1288

MLLV
PART II
ENGINEERING
BASE PLUG - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.1.6-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	25,530	301,509
Reliability Engineering	<u>540</u>	<u>6,377</u>
(1) Subtotal (A)	26,070	307,886
(2) Laboratory Technicians	<u>5,214</u>	<u>50,680</u>
Subtotal (B)	31,284	358,566
(3) Q&RA	<u>1,043</u>	<u>10,138</u>
Total Engineering Labor	<u>32,327</u>	<u>368,704</u>
Material		
(4) Lab. Tech.		10,949
(5) Q&RA		<u>313</u>
Subtotal (C)		11,262
(6) Material & Adm. Burden		<u>3,829</u>
Total Material		<u>15,091</u>
Total Engineering Cost		<u>383,795</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

BASE PLUG - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.6-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>28,394</u>	\$ <u>275,990</u>
(2) Miscellaneous Charges	<u>2,214</u>	<u>21,527</u>
(3) Maintain & Add in Scope Changes	<u>312</u>	<u>3,036</u>
Subtotal	30,921	300,552
(4) Tool & Production Planning	<u>9,351</u>	<u>90,887</u>
Subtotal	40,272	391,439
(5) Direct Distributable	<u>9,895</u>	<u>96,176</u>
Subtotal	50,166	487,615
(6) Training	<u>552</u>	<u>5,363</u>
Subtotal	50,718	492,979
(7) Q&RA	<u>10,144</u>	<u>98,596</u>
(8) Mfg. Tech.	<u>964</u>	<u>11,380</u>
Total Production Labor	<u>61,825</u>	\$ <u>602,954</u>
Material		
(9) Raw Material & Standards		\$ <u>164,000</u>
(10) Q&RA		<u>3,043</u>
(11) Mfg. Tech.		<u>1,686</u>
Material Subtotal		\$ 168,729
(12) Material & Adm. Burden		<u>57,368</u>
Total Material		\$ <u>226,097</u>
Total Production Cost		\$ <u>829,051</u>

MLLV
PART II
MANUFACTURING
TOOLING

BASE PLUG - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.1.6-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>2,474</u>	\$ <u>24,048</u>
(2) Direct Distributable	<u>792</u>	<u>7,694</u>
Subtotal	<u>3,266</u>	<u>31,742</u>
(3) Training	<u>36</u>	<u>349</u>
Subtotal	<u>3,302</u>	<u>32,091</u>
(4) Q&RA	<u>660</u>	<u>6,418</u>
Total Tooling Labor	<u><u>3,962</u></u>	\$ <u><u>38,509</u></u>
Material		
(5) Tooling	—	\$ <u>4,330</u>
(6) Q&RA		<u>198</u>
Subtotal		<u>4,528</u>
(7) Material & Adm. Burden		<u>1,539</u>
Total Material		<u>6,067</u>
Total Tooling Cost		\$ <u><u>44,576</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

BASE PLUG - S/S

TABLE 5.1.1.6-VII

<u>Estimate of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,420	13,802
Component Test Planning	454	4,417
Subtotal	<u>1,874</u>	<u>18,219</u>
Direct Distributable	600	5,830
Subtotal	<u>2,474</u>	<u>24,049</u>
Training	27	264
Subtotal	<u>2,501</u>	<u>24,313</u>
Mfg. Test	48	561
Subtotal	<u>2,549</u>	<u>24,874</u>
Q&RA	500	4,862
Total Mfg. Test Labor	<u>3,049</u>	<u>29,736</u>
Material		
Q&RA		150
Mfg. Tech.		83
Subtotal		<u>233</u>
Material & Adm. Burden		79
Total Material		<u>312</u>
Total Mfg. Test Cost		<u>30,048</u>

MLLV
PART III
FACILITY LABOR

BASE PLUG - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.6-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	928	\$9,020
TOTAL FACILITY LABOR COST	<u>.928</u>	<u>\$9,020</u>

MLLV
PART IV
LOGISTIC LABOR

BASE PLUG - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.6-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>3,930</u>	\$ <u>46,414</u>
(2) Hardware		220,080
(3) Material & Adm. Burden		<u>74,827</u>
Total Material		294,907
Total Logistic Cost		<u>\$341,321</u>

5.1.1.7 Structure Assembly

FINAL ASSEMBLY - SINGLE STAGE

TABLE 5.1.1.7-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	27								2	27
PROGRAM PLAN. & REPT.	6	68								6	68
INDUSTRIAL RELATIONS	1	12								1	12
ENGINEERING			89	1,057			14	159		103	1,216
LAB TECHNICIANS			18	174						18	174
TOOLING			3	28						3	28
PRODUCTION			47	455						47	455
MANUFACTURING TEST			2	21						2	21
MANUFACTURING TECH.			1	14						1	14
Q & R A			17	162						17	162
FACILITIES					1	11				1	11
DIRECT DIST			13	128						13	128
TRAINING			1	7						1	7
TOTAL DIRECT LABOR	9	107	191	2,046	1	11	14	159		215	2,323
MATERIAL				50							50
LOGISTIC HARDWARE											
BURDEN				17							17
TOTAL MATERIAL				67							67
TOTAL OTHER											
TOTAL COST		107		2,113		11		159			2,390

MLLV

PART I

FINAL ASSEMBLY
ASSEMBLY OR SYSTEM

TABLE 5.1.1.7-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	89,507		
Logistics	13,493		
Laboratory Technician	17,901		
Production	46,817		
Tooling	2,876		
Manufacturing Test	2,178		
Q&RA	16,721		
Facilities	1,078		
Manufacturing Technician	<u>1,175</u>		
Total Direct Labor	<u>191,746</u>		
Program Executive		2,301	\$ 27,175
Program Planning & Reporting		5,752	67,931
Industrial Relations		<u>1,246</u>	<u>12,111</u>
Total Labor - Part I		<u>9,299</u>	<u>\$107,217</u>
<u>Material</u>			
Program Planning & Reporting			115
Industrial Relations			12
Material Subtotal			127
Material & Administrative Burden			<u>43</u>
Total Material			<u>170</u>
TOTAL COST - PART I			<u>\$107,387</u>

TABLE 5.1.1.7-III
MLLV PART II COST SUMMARY

FINAL ASSEMBLY - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	89	1057							89	1057
LAB TECHNICIANS	18	174							18	174
TOOLING					3	28			3	28
PRODUCTION			46	455					46	455
MANUFACTURING TEST							2	21	2	21
MANUFACTURING TECH.			1	13				1	1	14
Q & R A	4	35	12	115	1	8	1	6	18	164
DIRECT DIST			12	112	1	9	1	7	14	128
TRAINING			1	6					1	6
TOTAL DIRECT LABOR	111	1266	72	701	5	45	4	35	192	2047
MATERIAL										
LAB. TECHNICIANS		38								38
TOOLING						5				5
PRODUCTION										
MFG. TECHNICIANS				2						2
Q & R A		1		3						4
SUBTOTAL		39		5		5				49
MAT. & ADM. BURDEN		13		2		2				17
TOTAL MATERIAL		52		7		7				66
TOTAL PART II COST		1318		708		52		35		2113

MLLV
PART II
ENGINEERING

FINAL ASSEMBLY - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.1.7-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	87,653	\$ 1,035,182
Reliability Engineering	1,854	21,896
(1) Subtotal (A)	89,507	1,057,078
(2) Laboratory Technicians	17,901	173,998
Subtotal (B)	107,408	1,231,076
(3) Q&RA	3,580	34,798
Total Engineering Labor	110,988	1,265,874
Material		
(4) Lab. Tech.		37,592
(5) Q&RA		1,074
Subtotal (C)		38,666
(6) Material & Adm. Burden		13,146
Total Material		51,812
Total Engineering Cost		\$ 1,317,686

MLLV
PART II
MANUFACTURING
PRODUCTION

STRUCTURE ASSEMBLY - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.7-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>33,009</u>	\$ <u>320,847</u>
(2) Miscellaneous Charges	<u>2,575</u>	<u>25,026</u>
(3) Maintain & Add in Scope Changes	<u>363</u>	<u>3,528</u>
Subtotal	35,947	349,402
(4) Tool & Production Planning	<u>10,870</u>	<u>105,658</u>
Subtotal	46,817	455,060
(5) Direct Distributable	<u>11,503</u>	<u>111,808</u>
Subtotal	58,320	566,868
(6) Training	<u>642</u>	<u>6,235</u>
Subtotal	58,961	573,103
(7) Q&RA	<u>11,792</u>	<u>114,620</u>
(8) Mfg. Tech.	<u>1,120</u>	<u>13,230</u>
Total Production Labor	<u>71,874</u>	\$ <u>700,953</u>
Material		
(9) Raw Material & Standards		\$ <u>-0-</u>
(10) Q&RA		<u>3,538</u>
(11) Mfg. Tech.		<u>1,960</u>
Material Subtotal		5,497
(12) Material & Adm. Burden		<u>1,869</u>
Total Material		\$ <u>7,367</u>
Total Production Cost		\$ <u>708,320</u>

MLIV
PART II
MANUFACTURING
TOOLING

STRUCTURE ASSEMBLY - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.7-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>2,876</u>	\$ <u>27,955</u>
(2) Direct Distributable	<u>920</u>	<u>8,945</u>
Subtotal	<u>3,796</u>	<u>36,900</u>
(3) Training	<u>42</u>	<u>405</u>
Subtotal	<u>3,838</u>	<u>37,305</u>
(4) Q&RA	<u>768</u>	<u>7,461</u>
Total Tooling Labor	<u><u>4,606</u></u>	\$ <u><u>44,766</u></u>
Material		
(5) Tooling		\$ <u>5,033</u>
(6) Q&RA		<u>230</u>
Subtotal		<u>5,263</u>
(7) Material & Adm. Burden		<u>1,789</u>
Total Material		<u><u>7,052</u></u>
Total Tooling Cost		\$ <u><u>51,818</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
STRUCTURES ASSEMBLY - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.7-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,650	16,038
Component Test Planning	528	5,132
Subtotal	2,178	21,170
Direct Distributable	697	6,774
Subtotal	2,875	27,944
Training	32	307
Subtotal	2,907	28,251
Mfg. Tech.	55	652
Subtotal	2,962	28,903
Q&RA	581	5,650
Total Mfg. Test Labor	3,543	34,553
Material		
Q&RA		174
Mfg. Tech.		97
Subtotal		271
Material & Adm. Burden		92
Total Material		363
Total Mfg. Test Cost		34,916

MLLV
PART III
FACILITY LABOR

STRUCTURE ASSEMBLY - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.1.7-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,078	\$10,478
TOTAL FACILITY LABOR COST	<u>1,078</u>	<u>\$10,478</u>

MLLV
PART IV
LOGISTIC LABOR
FINAL ASSEMBLY - S/S
ASSEMBLY OR SYSTEM
TABLE 5.1.1.7-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>13,493</u>	<u>\$159,352</u>
(2) Hardware		None
(3) Material & Adm. Burden		None
Total Material		None
Total Logistic Cost		<u>\$159,352</u>

5.1.2 Systems

The total first R&D flight test production unit cost of the systems for a single stage vehicle and the components thereof are displayed in Figure 5.1.2.0-1. Table 5.1.2.0-I is a total cost summary of the systems. Supporting documentation for each of the major components that are included in this cost summary are in the appropriate sections.

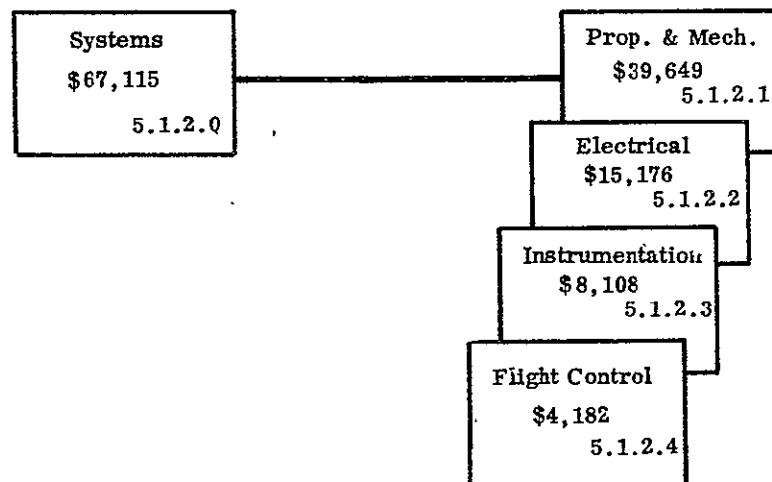
TABLE 5.1.2.0-I
MLLV COST SUMMARY

TOTAL SYSTEMS - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	37	432								37	432
PROGRAM PLAN. & REPT.	90	1,080								90	1,080
INDUSTRIAL RELATIONS	20	192								20	192
ENGINEERING			173	1,970			27	315		200	1,970
LAB TECHNICIANS			34	336						34	336
TOOLING			119	1,166						119	1,166
PRODUCTION			1,954	18,983						1,954	18,983
MANUFACTURING TEST			92	884						92	884
MANUFACTURING TECH.			49	579						49	579
Q & R A			554	5,611						554	5,611
FACILITIES					45	438				45	438
DIRECT DIST			547	5,320						547	5,320
TRAINING			29	290						29	290
TOTAL DIRECT LABOR	147	1,704	3,551	35,139	45	438	27	315		3,770	37,596
MATERIAL		3		25,890							25,893
LOGISTIC HARDWARE							1,492				1,492
BURDEN				1,809			325				2,134
TOTAL MATERIAL		3		27,699			1,817				29,519
TOTAL OTHER											
TOTAL COST		1,707		62,838		438	2,132				67,115



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 5.1.2.0-1 SINGLE STAGE SYSTEMS COST FLOW DIAGRAM

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5.1.2.1 Propulsion/Mechanical System

TABLE 5.1.2.1-I
MLLV COST SUMMARY

PROPULSION AND MECHANICAL SYSTEMS - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	15	172								15	172
PROGRAM PLAN. & REPT.	36	431								36	431
INDUSTRIAL RELATIONS	8	77								8	77
ENGINEERING			62	729			9	110		71	839
LAB TECHNICIANS			12	120						12	120
TOOLING			48	469						48	469
PRODUCTION			786	7,642						786	7,642
MANUFACTURING TEST			37	356						37	356
MANUFACTURING TECH.			20	233						20	233
Q & R A			223	2,385						223	2,385
FACILITIES					18	176				18	176
DIRECT DIST			220	2,142						220	2,142
TRAINING			12	117						12	117
TOTAL DIRECT LABOR	59	680	1,420	14,193	18	176	9	110		1,506	15,159
MATERIAL		1		22,973							22,974
LOGISTIC HARDWARE								521			521
BURDEN				818				177			995
TOTAL MATERIAL		1		23,791				698			24,490
TOTAL OTHER											
TOTAL COST		681		37,984		176		808			39,649

MLLV

PART I

PROPULSION AND MECHANICAL
ASSEMBLY OR SYSTEM

TABLE 5.1.2.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	61,699		
Logistics	9,301		
Laboratory Technician	12,340		
Production	786,242		
Tooling	48,295		
Manufacturing Test	36,588		
Q&RA	223,162		
Facilities	18,111		
Manufacturing Technician	19,742		
Total Direct Labor	<u>1,215,480</u>		
Program Executive		14,586	172,261
Program Planning & Reporting		36,464	430,640
Industrial Relations		7,901	76,798
Total Labor - Part I		<u>58,951</u>	<u>679,699</u>
<u>Material</u>			
Program Planning & Reporting			729
Industrial Relations			79
Material Subtotal			808
Material & Administrative Burden			275
Total Material			<u>1,083</u>
TOTAL COST - PART I			<u>680,782</u>

TABLE 5.1.2.1-III

PROPULSION AND MECHANICAL - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	62	729							62	729
LAB TECHNICIANS	13	120							13	120
TOOLING					48	469			48	469
PRODUCTION			786	7642					786	7642
MANUFACTURING TEST							37	356	37	356
MANUFACTURING TECH.			19	222			1	11	20	233
Q & R A	2	240	198	1925	13	125	10	95	223	2385
DIRECT DIST			193	1878	15	150	11	114	219	2142
TRAINING			11	105	1	7	1	5	13	117
TOTAL DIRECT LABOR	77	1089	1207	11772	77	751	60	581	1421	14193
MATERIAL										
LAB. TECHNICIANS		26								26
TOOLING						85				85
PRODUCTION				22762						22762
MFG. TECHNICIANS				33				2		35
Q & R A				59		3		3		66
SUBTOTAL		27		22854		88		5		22974
MAT. & ADM. BURDEN		8		777		31		1		817
TOTAL MATERIAL		35		23631		119		6		23791
TOTAL PART II COST		1124		35403		870		587		37984

MLLV
PART II
ENGINEERING

PROPULSION & MECHANICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.2.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	60,421	\$ 713,572
Reliability Engineering	1,278	15,093
(1) Subtotal	61,699	\$ 728,665
(2) Laboratory Technicians	12,340	119,945
Subtotal	74,039	\$ 848,610
(3) Q&RA	2,468	239,890
Total Engineering Labor	76,507	\$1,088,500
Material		
(4) Lab. Tech.		\$ 25,914
(5) Q&RA		740
Subtotal		\$ 26,654
(6) Material & Adm. Burden		9,062
Total Material		\$ 35,716
Total Engineering Cost		\$1,124,216

MLIV
PART II
MANUFACTURING
TOOLING

PROPULSION & MECHANICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	48,295	\$ 469,427
(2) Direct Distributable	15,454	150,217
Subtotal	63,749	619,644
(3) Training	701	6,816
Subtotal	64,450	626,460
(4) Q&RA	12,890	125,292
Total Tooling Labor	<u>77,340</u>	<u>\$ 751,752</u>
Material		
(5) Tooling		84,516
(6) Q&RA		3,867
Subtotal		88,383
(7) Material & Adm. Burden		30,050
Total Material		<u>118,433</u>
Total Tooling Cost		<u>\$ 870,185</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

PROP. & MECH. SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>(In Thousands Dollars)</u>
(1) Fabrication & Assembly	<u>554,350</u>	\$ <u>5,388</u>
(2) Miscellaneous Charges	<u>43,239</u>	<u>420</u>
(3) Maintain & Add in Scope Changes	<u>6,098</u>	<u>60</u>
Subtotal	603,687	5,868
(4) Tool & Production Planning	<u>182,555</u>	<u>1,774</u>
Subtotal	786,242	7,642
(5) Direct Distributable	<u>193,180</u>	<u>1,878</u>
Subtotal	979,422	9,520
(6) Training	<u>10,773</u>	<u>105</u>
Subtotal	990,195	9,625
(7) Q&RA	<u>198,039</u>	<u>1,925</u>
(8) Mfg. Tech.	<u>18,814</u>	<u>222</u>
Total Production Labor	<u>1,207,048</u>	\$ <u>11,772</u>
Material		
(9) Raw Material & Standards		\$ <u>22,762</u>
(10) Q&RA		<u>59</u>
(11) Mfg. Tech.		<u>33</u>
Material Subtotal		\$ <u>22,854</u>
(12) Material & Adm. Burden		<u>777</u>
Total Material		\$ <u>23,631</u>
Total Production Cost		\$ <u>35,403</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

PROPULSION & MECHANICAL SYSTEM - S/S

TABLE 5.1.2.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	27,718	269,419
Component Test Planning	8,870	86,213
Subtotal	<u>36,588</u>	<u>355,632</u>
Direct Distributable	11,708	113,802
Subtotal	<u>48,296</u>	<u>469,434</u>
Training	531	5,163
Subtotal	<u>48,827</u>	<u>474,597</u>
Mfg. Tech.	928	10,956
Subtotal	<u>49,755</u>	<u>485,553</u>
Q&RA	<u>9,765</u>	<u>94,919</u>
Total Mfg. Test Labor	<u>59,520</u>	<u>580,472</u>
Material		
Q&RA		2,930
Mfg. Tech.		<u>1,623</u>
Subtotal		4,553
Material & Adm. Burden		1,548
Total Material		<u>6,101</u>
Total Mfg. Test Cost		<u>586,573</u>

MLLV
PART III
FACILITY LABOR

PROPULSION & MECHANICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	18,111	\$176,038
TOTAL FACILITY LABOR COST	<u>18,111</u>	<u>\$176,038</u>

MLLV
PART IV
LOGISTIC LABOR
PROPULSION & MECHANICAL SYSTEM - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.2.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>9,301</u>	<u>\$109,845</u>
(2) Hardware		520,856
(3) Material & Adm. Burden		<u>177,091</u>
Total Material		<u>\$697,947</u>
Total Logistic Cost		<u>\$807,792</u>

5.1.2.2 Electrical System

TABLE 5.1.2.2-I
MLLV COST SUMMARY

ELECTRICAL - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	14	162								14	162
PROGRAM PLAN. & REPT.	34	405								34	405
INDUSTRIAL RELATIONS	7	72								7	72
ENGINEERING			30	289			5	58		35	347
LAB TECHNICIANS			6	58						6	58
TOOLING			47	458						47	458
PRODUCTION			767	7,451						767	7,451
MANUFACTURING TEST			36	347						36	347
MANUFACTURING TECH.			19	227						19	227
Q & R A			216	2,103						216	2,103
FACILITIES					18	172				18	172
DIRECT DIST			215	2,088						215	2,088
TRAINING			12	114						12	114
TOTAL DIRECT LABOR	55	639	1,348	13,135	18	172	5	58		1,426	14,004
MATERIAL		1		600							601
LOGISTIC HARDWARE								274			274
BURDEN				204				93			297
TOTAL MATERIAL		1		804				367			1,172
TOTAL OTHER											
TOTAL COST		640		13,939		172		425			15,176

MLLV

PART I

ELECTRICAL
ASSEMBLY OR SYSTEM

TABLE 5.1.2.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	29,785		
Logistics	4,885		
Laboratory Technician	5,957		
Production	766,552		
Tooling	47,086		
Manufacturing Test	35,670		
Q&RA	216,358		
Facilities	17,657		
Manufacturing Technician	<u>19,247</u>		
Total Direct Labor	<u>1,143,197</u>		
Program Executive		13,718	162,010
Program Planning & Reporting		34,296	405,036
Industrial Relations		<u>7,431</u>	<u>72,229</u>
Total Labor - Part I		<u>55,445</u>	<u>639,275</u>
<u>Material</u>			
Program Planning & Reporting			686
Industrial Relations			<u>74</u>
Material Subtotal			760
Material & Administrative Burden			<u>258</u>
Total Material			<u>1,018</u>
TOTAL COST - PART I			<u>640,293</u>

TABLE 5.1.2.2-III

ELECTRICAL - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	30	290							30	290
LAB TECHNICIANS	6	58							6	58
TOOLING					47	458			47	458
PRODUCTION			767	7,451					767	7,451
MANUFACTURING TEST							36	347	36	347
MANUFACTURING TECH.			18	217			1	11	19	228
Q & R A	1	11	193	1,877	12	122	10	93	216	2,103
DIRECT DIST			188	1,831	14	146	11	111	213	2,088
TRAINING			11	101	1	7		4	12	112
TOTAL DIRECT LABOR	37	359	1,177	11,477	74	733	58	566	1,346	13,135
MATERIAL										
LAB. TECHNICIANS		13								13
TOOLING						82				82
PRODUCTION				407						407
MFG. TECHNICIANS				32			2			34
Q & R A				58		4		2		64
SUBTOTAL		13		497		86		4		600
MAT. & ADM. BURDEN		4		169		29		2		204
TOTAL MATERIAL		17		666		115		6		804
TOTAL PART II COST		376		12143		848		572		13,939

MLLV
PART II
ENGINEERING

ELECTRICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.2.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	29,155	\$283,387
Reliability Engineering	<u>630</u>	<u>6,123</u>
(1) Subtotal	29,785	\$289,510
(2) Laboratory Technicians	<u>5,957</u>	<u>57,902</u>
Subtotal	35,742	\$347,412
(3) Q&RA	<u>1,191</u>	<u>11,577</u>
Total Engineering Labor	<u><u>36,933</u></u>	<u><u>\$358,989</u></u>
Material		
(4) Lab. Tech.		\$ 12,510
(5) Q&RA		<u>357</u>
Subtotal		\$ 12,867
(6) Material & Adm. Burden		<u>4,375</u>
Total Material		<u><u>\$ 17,242</u></u>
Total Engineering Cost		<u><u>\$376,231</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION

ELECTRICAL SYSTEM - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.2.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>540,467</u>	<u>\$5,253,339</u>
(2) Miscellaneous Charges	<u>42,156</u>	<u>409,760</u>
(3) Maintain & Add in Scope Changes	<u>5,945</u>	<u>57,786</u>
Subtotal	588,569	5,720,886
(4) Tool & Production Planning	<u>177,983</u>	<u>1,729,996</u>
Subtotal	766,552	7,450,881
(5) Direct Distributable	<u>188,342</u>	<u>1,830,683</u>
Subtotal	954,894	9,281,565
(6) Training	<u>10,504</u>	<u>102,097</u>
Subtotal	965,397	9,383,662
(7) Q&RA	<u>193,079</u>	<u>1,876,732</u>
(8) Mfg. Tech.	<u>18,343</u>	<u>216,625</u>
Total Production Labor	<u>1,176,819</u>	<u>\$11,477,018</u>
Material		
(9) Raw Material & Standards		\$ <u>407,000</u>
(10) Q&RA		<u>57,924</u>
(11) Mfg. Tech.		<u>32,099</u>
Material Subtotal		\$ 497,023
(12) Material & Adm. Burden		<u>168,988</u>
Total Material		\$ <u>666,011</u>
Total Production Cost		<u>\$12,143,029</u>

MLLV
PART II
MANUFACTURING
TOOLING

ELECTRICAL SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	47,086	457,676
(2) Direct Distributabel	<u>15,068</u>	<u>146,456</u>
Subtotal (A)	62,154	604,132
(3) Training	<u>684</u>	<u>6,645</u>
Subtotal (B)	63,837	610,777
(4) Q&RA	<u>12,567</u>	<u>122,155</u>
Total Tooling Labor	<u><u>75,404</u></u>	<u><u>732,932</u></u>
Material		
(5) Tooling		82,401
(6) Q&RA		<u>3,770</u>
Subtotal (C)		86,171
(7) Material & Adm. Burden		<u>29,298</u>
Total Material		<u><u>115,469</u></u>
Total Tooling Cost		<u><u>848,401</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
ELECTRICAL SYSTEM - S/S

TABLE 5.1.2.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	27,023	262,664
Component Test Planning	<u>8,647</u>	<u>84,052</u>
Subtotal	35,670	346,716
Direct Distributable	<u>11,414</u>	<u>110,948</u>
Subtotal	47,085	457,664
Training	<u>518</u>	<u>5,034</u>
Subtotal	47,603	462,698
Mfg. Tech.	<u>904</u>	<u>10,681</u>
Subtotal	48,507	473,379
Q&RA	<u>9,521</u>	<u>92,539</u>
Total Mfg. Test Labor	<u>58,028</u>	<u>565,918</u>
Material		
Q&RA		2,856
Mfg. Tech.		<u>1,583</u>
Subtotal		4,439
Material & Adm. Burden		<u>1,509</u>
Total Material		<u>5,948</u>
Total Mfg. Test Cost		<u>571,866</u>

MLLV
PART III
FACILITY LABOR

ELECTRICAL SYSTEM - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.2.2-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	17,657	\$171,626
TOTAL FACILITY LABOR COST	<u>17,657</u>	<u>\$171,626</u>

MLLV
 PART IV
 LOGISTIC LABOR
ELECTRICAL SYSTEM - S/S
 ASSEMBLY OR SYSTEM
 TABLE 5.1.2.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>4,885</u>	\$ 57,692
(2) Hardware		273,560
(3) Material & Adm. Burden		<u>93,010</u>
Total Material		<u>\$366,570</u>
Total Logistic Cost		<u>\$424,262</u>

5.1.2.3 Instrumentation System

TABLE 5.1.2.3-I
MLLV COST SUMMARY

INSTRUMENTATION - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	6	77								6	77
PROGRAM PLAN. & REPT.	16	193								16	193
INDUSTRIAL RELATIONS	4	34								4	34
ENGINEERING			69	808			11	125		80	933
LAB TECHNICIANS			14	134						14	134
TOOLING			19	186						19	186
PRODUCTION			312	3,030						312	3,030
MANUFACTURING TEST			15	141						15	141
MANUFACTURING TECH.			8	93						8	93
Q & R A			90	877						90	877
FACILITIES					7	70				7	70
DIRECT DIST			87	849						87	849
TRAINING			4	46						4	46
TOTAL DIRECT LABOR	26	304	618	6,164	7	70	11	125		662	6,663
MATERIAL		1		619							620
LOGISTIC HARDWARE								595			595
BURDEN				210				20			230
TOTAL MATERIAL		1		829				615			1,445
TOTAL OTHER											
TOTAL COST		305		6,993		70		740			8,108

MLLV

PART I

INSTRUMENTATION - S/S
ASSEMBLY OR SYSTEM

TABLE 5.1.2.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	68,931		
Logistics	10,611		
Laboratory Technician	13,786		
Production	311,727		
Tooling	19,148		
Manufacturing Test	14,505		
Q&RA	90,258		
Facilities	7,180		
Manufacturing Technician	<u>7,827</u>		
Total Direct Labor	<u>543,973</u>		
Program Executive		6,528	77,096
Program Planning & Reporting		16,319	192,727
Industrial Relations		<u>3,536</u>	<u>34,370</u>
Total Labor - Part I		<u>26,383</u>	<u>304,193</u>
<u>Material</u>			
Program Planning & Reporting			326
Industrial Relations			35
Material Subtotal			361
Material & Administrative Burden			<u>123</u>
Total Material			<u>484</u>
TOTAL COST - PART I			<u>304,677</u>

TABLE 5.1.2.3-III
MLLV PART II COST SUMMARY

INSTRUMENTATION - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	68	808							68	808
LAB TECHNICIANS	14	134							14	134
TOOLING					19	186			19	186
PRODUCTION			311	3,030					311	3,030
MANUFACTURING TEST							15	141	15	141
MANUFACTURING TECH.			7	88				4	7	92
Q & R A	3	27	79	763	5	50	4	38	91	878
DIRECT DIST			77	744	6	60	5	45	88	849
TRAINING			4	42	1	2		2	5	46
TOTAL DIRECT LABOR	85	969	478	4,667	31	298	24	230	618	6,164
MATERIAL										
LAB. TECHNICIANS		29								29
TOOLING						34				34
PRODUCTION				516						516
MFG. TECHNICIANS				13				1		14
Q & R A		1		24		1		1		27
SUBTOTAL		30		553		35		2		620
MAT. & ADM. BURDEN		10		187		12		1		210
TOTAL MATERIAL		40		740		47		3		830
TOTAL PART II COST		1,009		5,407		345		233		6,994

MLLV
PART II
ENGINEERING

INSTRUMENTATION SYSTEM - S/S

ASSEMBLY OR SYSTEM

TABLE 5.1.2.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	66,977	\$ 790,998
Reliability Engineering	<u>1,458</u>	<u>17,219</u>
(1) Subtotal	68,931	\$ 808,217
(2) Laboratory Technicians	<u>13,786</u>	<u>134,000</u>
Subtotal	82,712	\$ 942,217
(3) Q&RA	<u>2,757</u>	<u>26,798</u>
Total Engineering Labor	<u>85,474</u>	<u>\$ 969,015</u>
Material		
(4) Lab. Tech.		\$ 28,951
(5) Q&RA		<u>827</u>
Subtotal		\$ 29,778
(6) Material & Adm. Burden		<u>10,125</u>
Total Material		<u>\$ 39,903</u>
Total Engineering Cost		<u>\$1,008,918</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

INSTRUMENTATION SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>219,787</u>	<u>\$2,136,330</u>
(2) Miscellaneous Charges	<u>17,143</u>	<u>166,633</u>
(3) Maintain & Add in Scope Changes	<u>2,418</u>	<u>23,499</u>
Subtotal	239,348	2,326,461
(4) Tool & Production Planning	<u>72,379</u>	<u>703,522</u>
Subtotal	311,727	3,029,983
(5) Direct Distributable	<u>76,591</u>	<u>744,467</u>
Subtotal	388,318	3,774,451
(6) Training	<u>4,271</u>	<u>41,518</u>
Subtotal	392,589	3,815,969
(7) Q&RA	<u>78,518</u>	<u>763,193</u>
(8) Mfg. Tech.	<u>7,459</u>	<u>88,092</u>
Total Production Labor	<u>478,566</u>	<u>4,667,254</u>
Material		
(9) Raw Material & Standards		<u>\$ 515,505</u>
(10) Q&RA		<u>23,555</u>
(11) Mfg. Tech.		<u>13,053</u>
Material Subtotal		552,113
(12) Material & Adm. Burden		<u>187,718</u>
Total Material		<u>\$ 739,831</u>
Total Production Cost		<u>\$5,407,085</u>

MLLV
PART II
MANUFACTURING
TOOLING

INSTRUMENTATION SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	19,148	\$ 186,119
(2) Direct Distributable	6,127	59,557
Subtotal	25,275	245,676
(3) Training	278	2,702
Subtotal	25,553	248,378
(4) Q&RA	5,111	49,675
Total Tooling Labor	30,664	\$ 298,053
Material		
(5) Tooling		\$ 33,509
(6) Q&RA		1,533
Subtotal		35,042
(7) Material & Adm. Burden		11,914
Total Material		46,956
Total Tooling Cost		\$ 345,009

MLIV
PART II
MANUFACTURING
MANUFACTURING TEST
INSTRUMENTATION SYSTEM - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	10,989	106,813
Component Test Planning	<u>3,516</u>	<u>34,179</u>
(1) Subtotal (A)	14,505	140,992
(2) Direct Distributable	<u>4,642</u>	<u>45,117</u>
Subtotal (B)	19,147	186,109
(3) Training	<u>211</u>	<u>2,047</u>
Subtotal (C)	19,358	188,156
(4) Mfg. Tech.	<u>368</u>	<u>4,343</u>
Subtotal (D)	19,726	192,499
(5) Q&RA	<u>3,872</u>	<u>37,631</u>
Total Mfg. Test Labor	<u>23,598</u>	<u>230,130</u>
Material		
(6) Q&RA		1,161
(7) Mfg. Tech.		<u>643</u>
Subtotal (E)		1,804
(8) Material & Adm. Burden		<u>614</u>
Total Material		<u>2,418</u>
Total Mfg. Test Cost		<u>232,548</u>

MLLV
PART III
FACILITY LABOR

INSTRUMENTATION

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	7,180	\$69,790
TOTAL FACILITY LABOR COST	<u>7,180</u>	<u>\$69,790</u>

MLLV
 PART IV
 LOGISTIC LABOR
 INSTRUMENTATION SYSTEM
 : ASSEMBLY OR SYSTEM
 TABLE 5.1.2.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>10,611</u>	\$ <u>125,316</u>
(2) Hardware		594,216
(3) Material & Adm. Burden		20,233
Total Material		<u>614,449</u>
Total Logistic Cost		<u>\$ 739,765</u>

5.1.2.4 Flight Control System

TABLE 5.1.2.4-I
MLLV COST SUMMARY

FLIGHT CONTROL - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	21								2	21
PROGRAM PLAN. & REPT.	4	51								4	51
INDUSTRIAL RELATIONS	1	9								1	9
ENGINEERING			12	144			2	22		14	166
LAB TECHNICIANS			2	24						2	24
TOOLING			5	53						5	53
PRODUCTION			89	860						89	860
MANUFACTURING TEST			4	40						4	40
MANUFACTURING TECH.			2	26						2	26
Q & R A			25	246						25	246
FACILITIES					2	20				2	20
DIRECT DIST			25	241						25	241
TRAINING			1	13						1	13
TOTAL DIRECT LABOR	7	81	165	1,647	2	20	2	22		176	1,770
MATERIAL											
LOGISTIC HARDWARE								102			102
BURDEN				577				35			612
TOTAL MATERIAL				2,275				137			2,412
TOTAL OTHER											
TOTAL COST		81		3,922		20		159			4,182

MLLV

PART I

FLIGHT CONTROL
ASSEMBLY OR SYSTEM

TABLE 5.1.2.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	12,166		
Logistics	1,834		
Laboratory Technician	2,433		
Production	88,517		
Tooling	5,437		
Manufacturing Test	4,120		
Q&RA	25,336		
Facilities	2,039		
Manufacturing Technician	2,222		
Total Direct Labor	<u>144,104</u>		
Program Executive		1,729	20,419
Program Planning & Reporting		4,323	51,055
Industrial Relations		937	9,108
Total Labor - Part I		<u>6,989</u>	<u>80,582</u>
<u>Material</u>			
Program Planning & Reporting			86
Industrial Relations			9
Material Subtotal			95
Material & Administrative Burden			32
Total Material			<u>127</u>
TOTAL COST - PART I			<u>80,709</u>

TABLE 5.1.2.4-III

FLIGHT CONTROL - S/S

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	12	144							12	144
LAB TECHNICIANS	2	24							2	24
TOOLING					5	53			5	53
PRODUCTION			89	860					89	860
MANUFACTURING TEST							4	40	4	40
MANUFACTURING TECH.			2	25				1	2	26
Q & R A	1	4	22	217	1	14	1	11	25	246
DIRECT DIST			22	211	2	17	2	13	26	241
TRAINING				12	1	1			1	13
TOTAL DIRECT LABOR	15	172	135	1,325	9	85	7	65	166	1,647
MATERIAL										
LAB. TECHNICIANS		5								5
TOOLING						10				10
PRODUCTION				1,672						1,672
MFG. TECHNICIANS				4						4
Q & R A				6						6
SUBTOTAL		5		1,682		10		1		1,698
MAT. & ADM. BURDEN		2		572		3				577
TOTAL MATERIAL		7		2,254		13		1		2,275
TOTAL PART II COST		179		3,579		98		66		3,922

MLLV
PART II
ENGINEERING

FLIGHT CONTROL SYSTEMS

ASSEMBLY OR SYSTEM

TABLE 5.1.2.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	11,914	\$140,704
Reliability Engineering	<u>252</u>	<u>2,976</u>
(1) Subtotal	12,166	\$143,680
(2) Laboratory Technicians	<u>2,433</u>	<u>23,649</u>
Subtotal	14,599	\$167,329
(3) Q&RA	<u>489</u>	<u>4,734</u>
Total Engineering Labor	<u>15,086</u>	<u>\$172,063</u>
Material		
(4) Lab. Tech.		\$ 5,109
(5) Q&RA		<u>146</u>
Subtotal		\$ 5,255
(6) Material & Adm. Burden		<u>1,787</u>
Total Material		<u>\$ 7,042</u>
Total Engineering Cost		<u>\$179,105</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

FLIGHT CONTROL SYSTEM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>62,410</u>	<u>606,625</u>
(2) Miscellaneous Charges	<u>4,868</u>	<u>47,316</u>
(3) Maintain & Add in Scope Changes	<u>687</u>	<u>6,673</u>
Subtotal	67,964	660,614
(4) Tool & Production Planning	<u>20,552</u>	<u>199,769</u>
Subtotal	88,517	860,383
(5) Direct Distributable	<u>21,749</u>	<u>211,396</u>
Subtotal	110,265	1,071,779
(6) Training	<u>1,213</u>	<u>11,789</u>
Subtotal	111,478	1,083,569
(7) Q&RA	<u>22,296</u>	<u>216,713</u>
(8) Mfg. Tech.	<u>2,118</u>	<u>25,014</u>
Total Production Labor	<u>135,892</u>	<u>\$1,325,295</u>
Material		
(9) Raw Material & Standards.		<u>\$1,671,679</u>
(10) Q&RA		<u>6,689</u>
(11) Mfg. Tech.		<u>3,707</u>
Material Subtotal		\$1,682,074
(12) Material & Adm. Burden		<u>571,905</u>
Total Material		<u>\$2,253,979</u>
Total Production Cost		<u>\$3,579,274</u>

MLIV .
PART II
MANUFACTURING
TOOLING

FLIGHT CONTROL SYSTEM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>5,437</u>	\$ <u>52,847</u>
(2) Direct Distributable	<u>1,740</u>	<u>16,911</u>
Subtotal	7,177	69,758
(3) Training	<u>79</u>	<u>767</u>
Subtotal	7,256	70,525
(4) Q&RA	<u>1,451</u>	<u>14,105</u>
Total Tooling Labor	<u><u>8,707</u></u>	\$ <u><u>84,630</u></u>
Material		
(5) Tooling		\$ <u>9,515</u>
(6) Q&RA		<u>435</u>
Subtotal		9,950
(7) Material & Adm. Burden		<u>3,383</u>
Total Material		<u><u>13,333</u></u>
Total Tooling Cost		\$ <u><u>97,963</u></u>

MLIV
PART IIB
MANUFACTURING
MANUFACTURING TEST
FLIGHT CONTROL SYSTEM - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.2.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	3,121	30,336
Component Test Planning	999	9,707
(1) Subtotal (A)	4,120	40,043
(2) Direct Distributable	1,318	12,814
Subtotal (B)	5,438	52,857
(3) Training	60	581
Subtotal (C)	5,498	53,438
(4) Mfg. Tech.	104	1,233
Subtotal (D)	5,602	54,671
(5) Q&RA	1,100	10,687
Total Mfg. Test Labor	6,702	65,358
Material		
(6) Q&RA		330
(7) Mfg. Tech.		183
Subtotal (E)		513
(8) Material & Adm. Burden		174
Total Material		687
Total Mfg. Test Cost		<u>\$ 66,045</u>

MLLV
PART III
FACILITY LABOR

FLIGHT CONTROL SYSTEM
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.2.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	2,039	\$19,819
TOTAL FACILITY LABOR COST	<u>2,039</u>	<u>\$19,819</u>

MLLV
PART IV
LOGISTIC LABOR
FLIGHT CONTROL
ASSEMBLY OR SYSTEM
TABLE 5.1.2.4-IX

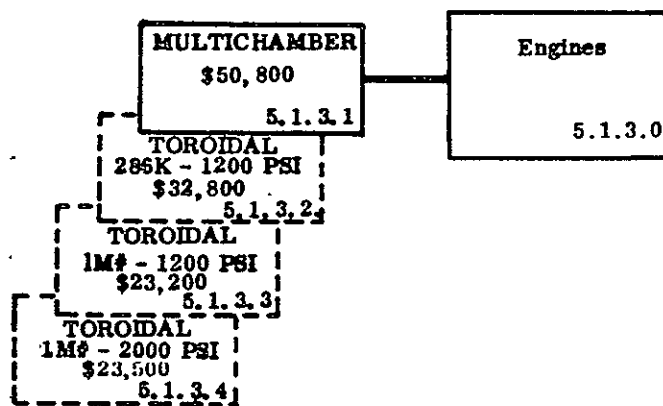
<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,834</u>	\$ <u>21,660</u>
(2) Hardware		102,704
(3) Material & Adm. Burden		<u>34,919</u>
Total Material		<u>\$137,623</u>
Total Logistic Cost		<u>\$159,283</u>

5.1.3 Liquid Engine Costs

This section shows the first R&D flight test engine costs for the following types of engines:

- 5.1.3.1 - Multichamber/Plug (with 24 modules having fixed nozzles and a vacuum thrust of 388,000 pounds)
- 5.1.3.2 - Toroidal/Aerospike (1200 psia with 28 modules each producing 286,000 pounds thrust)
- 5.1.3.3 - Toroidal/Aerospike (1200 psia with 8 modules each producing one million pounds thrust)
- 5.1.3.4 - Toroidal/Aerospike (2000 psia with 8 modules each producing one million pounds thrust)

Figure 5.1.3.0-I shows the engine options available for the main stage propulsion system.



NOTES: - - - - ALTERNATE SYSTEMS.
 DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 5.1.3.0-1 SINGLE STAGE ENGINE OPTIONS COST FLOW DIAGRAM

5.1.3.1 Multichamber/Plug Engine

Parametric cost data was received from Pratt and Whitney for the multichamber/plug propulsion system. This data covered a range of propulsion system sizes from above the requirements for a full size AMLLV engine to below that of a half size (MLLV) engine (Figure 5.1.3.1-1). The data received was gross and included only a total cost for production. To develop this data into more meaningful cost information, detailed subdivisions of cost were developed from historical data for the J-2 engine system.

As illustrated in Figure 5.1.3.1-1, total production costs were provided in terms of average unit costs for a 100, 200, and 500 module program as a function of module vacuum thrust. The average unit cost of a 100 engine program (for a 388,000 lb thrust engine) is \$1.95M. Using this data, it was necessary to determine a first unit cost. The module first unit cost and the cost for the first set of 24 multichamber/plug engines were developed as shown below:

First Unit

$\$1.95\text{M Average} \times 100 = \195.0M
 $100 \text{ Unit (Cum) } 95\% \text{ Curve} = \76.58M
 $195.0 \text{ M} \div 76.58 = \2.5M
 $24 \text{ Units} = 20.30 \text{ (95\%)} \times 2.5 \text{ m} = \50.8M

The engine system costs are summarized below:

"C" Costs

Engineering	\$2.4 M
Test	3.3 M
Tooling (maintenance)	3.7 M
Fabrication	<u>41.4 M</u>
Subtotal	\$50.8 M

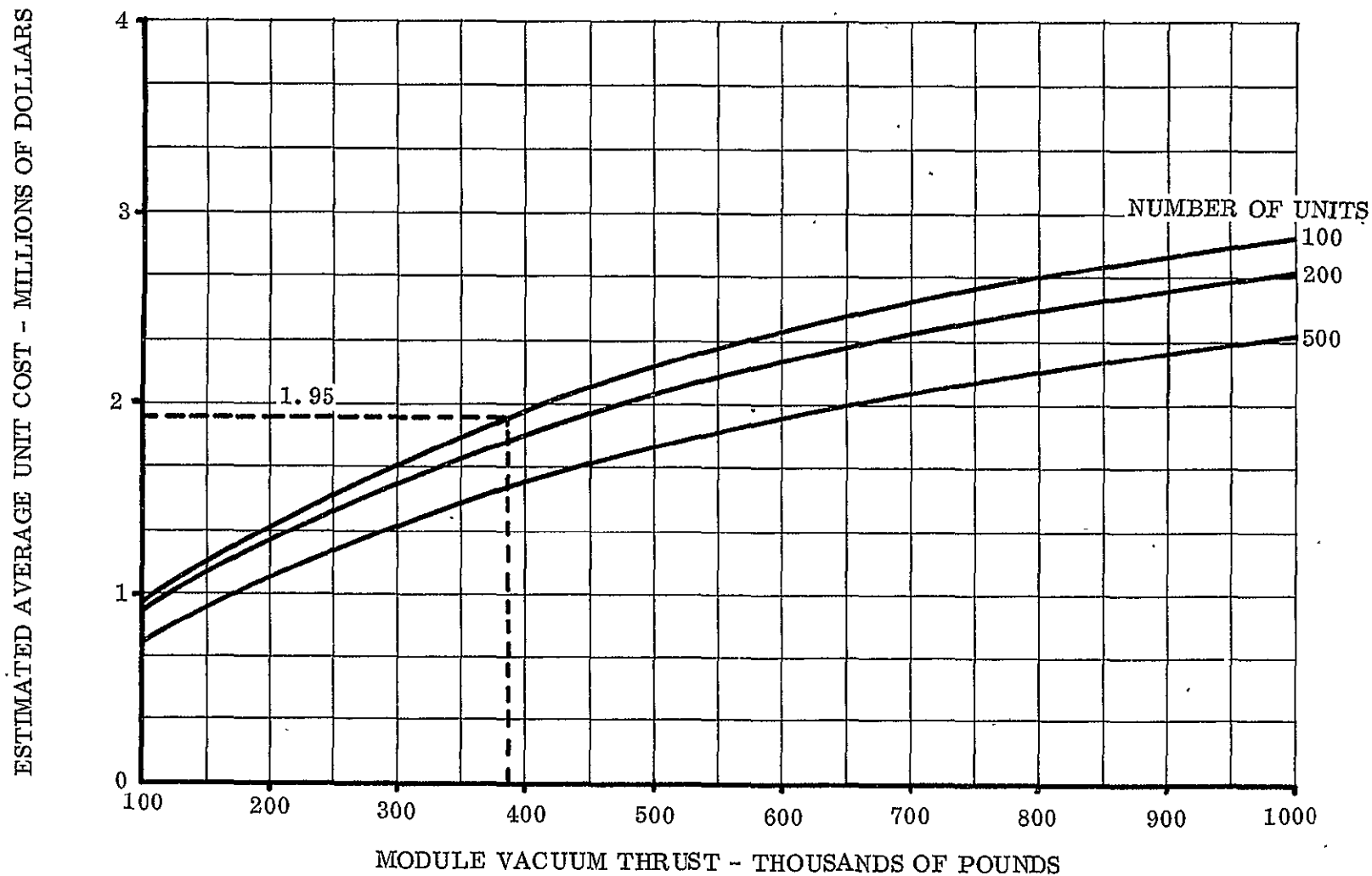


FIGURE 5.1.3.1-1 MLLV MULTICHAMBER/PLUG ENGINE MODULE AVERAGE UNIT COST

TABLE 5.1.3.1-I

MLLV COST SUMMARY SINGLE STAGE ENGINE (MULTI-CHAMBER)

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				2,400							2,400
LAB TECHNICIANS											
TOOLING				3,700							3,700
PRODUCTION				41,400							41,400
MANUFACTURING TEST				3,300							3,300
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				50,800							50,800
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST				50,800							50,800

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5.1.3.2 Toroidal/Aerospike Engine Cost - 1200 psia, 286,000 Pounds Thrust - 28 Modules

This section presents the cost for a toroidal/aerospike engine system with a chamber pressure consisting of 1200 psia and twenty-eight modules each of which will produce 286,000 pounds of sea-level thrust. Costs for this alternative engine were supplied by Rocketdyne.

The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 5.1.0.0-I above. These costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the toroidal/aerospike engine system.

The module costs and the overall engine system costs are summarized below.

"C" Costs

Engineering	\$ 1.41 m
Test	1.87
Tooling (maintenance)	2.11
Fabrication	23.66
Fee	<u>3.75</u>

Total \$32.80

$$28 \text{ Modules Per Engine} = 23.4462 (95\%) \times \$1.40 \text{ m} = \$32.8 \text{ m}$$

TABLE 5.1.3.2-1. 1200 PSIA, 286,000 Pounds Thrust - 28 Modules

MLLV COST SUMMARY

SINGLE STAGE ENGINES (TOROIDAL)

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				1,410							1,410
LAB TECHNICIANS											
TOOLING				2,110							2,110
PRODUCTION				23,660							23,660
MANUFACTURING TEST				1,870							1,870
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				29,050							29,050
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									*3,750		3,750
TOTAL COST				29,050					3,750		32,800

*FEE

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MLLV
TOROIDAL ENGINE PROGRAM
286K THRUST PER MODULE
1200 PSI
(FIRST UNIT)

TABLE 5.1.3.2-II

		(In Millions)
C. Operational		
Engineering	\$.06	\$ 1.41
Test	.08	1.87
Tooling (Maintenance)	.09	2.11
Fabrication	1.01	23.66
Fee	.16	3.75
	<hr/>	<hr/>
Total	\$ 1.40	\$32.80

28 Modules Per Engine =

Cum For 28 = 23.4462 (95%) X \$1.40m = \$32.8m

5.1.3.3 Toroidal/Aerospike Engine Cost - 1200 psia, 1,000,000 Pounds Thrust - 8 Modules

This section presents the cost for a toroidal/aerospike engine system with a chamber pressure of 1200 psia and eight modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine were supplied by Rocketdyne.

The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 5.1.0.0-I above. These costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the 1200 psia, 1,000,000 pound thrust toroidal/aerospike engine system.

The module costs and the overall engine system costs are summarized below.

"C" Costs

Engineering	1.02 M
Test	1.23 M
Tooling (maintenance)	1.74 M
Fabrication	17.11 M
Fee	<u>2.10 M</u>
Total	23.20 M

8 Modules Per Engine = 7,2612 (95%) X 3.20 M = \$23.2 M

TABLE 5.1.3.3-I

MLLV COST SUMMARY

SINGLE STAGE ENGINES (TOROIDAL)

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				1,020							1,020
LAB TECHNICIANS											
TOOLING				1,740							1,740
PRODUCTION				17,110							17,110
MANUFACTURING TEST				1,230							1,230
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				21,100							21,100
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									2,100		2,100
TOTAL COST				21,100					2,100		23,200

MLLV
TOROIDAL ENGINE PROGRAM
1m THRUST PER MODULE
1200 PSI
(FIRST UNIT)

TABLE 5.1.3.3-II

(In Millions)

C. Operational

Engineering	\$.14	\$ 1.02
Test	.17	1.23
Tooling (Maintenance)	.24	1.74
Fabrication	2.36	17.11
Fee	.29	2.10
	<hr/>	<hr/>
Total	\$ 3.20	\$23.30

8 Modules Per Engine

Cum for 8 Modules = 7.2612 (95%) X \$3.20 = \$23.2 m

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5.1.3.4 Toroidal/Aerospike Cost - 2000 psia, 1,000,000 Pounds Thrust -
8 Modules

This section presents the cost for a toroidal/aerospike engine system with a chamber pressure of 2000 psia and eight modules, each of which will produce one million pounds of sea level thrust. Costs for this alternative engine were supplied by Rocketdyne

The costs for this engine configuration are not added in the cost summary for the single stage vehicle shown in Table 5.1.0.0-I above. These costs must be substituted in lieu of those for the multichamber/plug engine to define the cost of the single stage vehicle with the 2000 psia, one million pound thrust toroidal/aerospike engine system.

The module costs and the overall engine system costs are summarized below.

"C" Costs

Engineering	\$ 1.1 M
Test	1.3 M
Tooling (maintenance)	2.0 M
Fabrication	<u>19.1 M</u>
Total	\$23.5 M

8 Modules Per Engine = 7.2612 (95%) X 3.24 M = \$23.5 M

TABLE 5.1.3.4-I

MLLV COST SUMMARY

SINGLE STAGE ENGINES (TOROIDAL)

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				1,100							1,100
LAB TECHNICIANS											
TOOLING				2,000							2,000
PRODUCTION				19,100							19,100
MANUFACTURING TEST				1,300							1,300
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				23,500							23,500
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST				23,500							23,500

MLLV
TOROIDAL ENGINE PROGRAM
1m THRUST PER MODULE
2000 PSI
(FIRST UNIT)

TABLE 5.1.3.4-II
"C" COSTS

(DOLLARS IN MILLIONS)

Engineering	.15	1.1
Test	.18	1.3
Tooling (Maintenance)	.27	2.0
Fabrication	<u>2.64</u>	<u>19.1</u>
Subtotal (Fee not Incl.)	3.24	23.5

8 modules per engine = 7.2612 (95%) X \$3.24m = \$23.5m

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5.1.4 Engine Installation

Installation costs associated with the twenty-four (24) multichamber/plug engines were based on manhour estimates which were derived from Saturn V historical data. In addition to the direct factory labor, all supporting costs were included.

TABLE 5.1.4.0-I

MLLV COST SUMMARY ENGINE INSTALLATION - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	10								1	10
PROGRAM PLAN.& REPT.	2	25								2	25
INDUSTRIAL RELATIONS	1	4								1	4
ENGINEERING											
LAB TECHNICIANS											
TOOLING			3	28						3	28
PRODUCTION			46	448						46	448
MANUFACTURING TEST			5	42						5	42
MANUFACTURING TECH.			1	14						1	14
Q & RA			14	131						14	131
FACILITIES					1	9				1	9
DIRECT DIST			14	132						14	132
TRAINING			1	7						1	7
TOTAL DIRECT LABOR	4	39	84	802	1	9				89	850
MATERIAL.				11							11
LOGISTIC HARDWARE											
BURDEN				4							4
TOTAL MATERIAL				15							15
TOTAL OTHER											
TOTAL COST		39		817		9					865

MLLV
RECURRING
PART I
ENGINE INSTALLATION - S/S
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	_____		
Logistics	_____		
Laboratory Technician	_____		
Production	<u>46,047</u>		
Tooling	<u>2,828</u>		
Manufacturing Test	<u>4,335</u>		
Q&RA	<u>13,510</u>		
Facilities	<u>971</u>		
Manufacturing Technician	<u>1,212</u>		
Total Direct Labor	<u>68,903</u>		
Program Executive		<u>827</u>	\$ <u>9,76</u>
Program Planning & Reporting		<u>2,067</u>	<u>24,4</u>
Industrial Relations		<u>448</u>	<u>4,3</u>
Total Labor - Part I		<u>3,342</u>	\$ <u>38,5</u>
<u>Material</u>			
Program Planning & Reporting			<u>1</u>
Industrial Relations			<u>1</u>
Material Subtotal			<u>8</u>
Material & Administrative Burden			<u>2</u>
Total Material			<u>10</u>
TOTAL COST - PART I			\$ <u>38,61</u>

TABLE 5.1.4.0-III

MLIV PART II COST SUMMARY ENGINE INSTALLATION - S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					3	27			3	27
PRODUCTION			46	447					46	447
MANUFACTURING TEST							4	42	4	42
MANUFACTURING TECH.			1	13				1	1	14
Q & R A			12	113	1	8	1	11	14	132
DIRECT DIST			111	110	1	9	1	14	13	133
TRAINING			1	6				1	1	7
TOTAL DIRECT LABOR			71	689	5	44	6	69	82	802
MATERIAL										
LAB. TECHNICIANS										
TOOLING						5				5
PRODUCTION										
MFG. TECHNICIANS				2						2
Q & R A				3						3
SUBTOTAL				5		5				10
MAT. & ADM. BURDEN				3		2				5
TOTAL MATERIAL				8		7				15
TOTAL PART II COST				697		51		69		817

PART IIB
MANUFACTURING
PRODUCTION
ENGINE INSTALLATION - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.4.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	32,467	\$ 315,579
(2) Miscellaneous Charges	2,532	24,611
(3) Maintain & Add in Scope Changes	357	3,470
Subtotal (A)	35,356	\$ 343,660
(4) Tool & Production Planning	10,691	103,917
Subtotal (B)	46,047	\$ 447,577
(5) Direct Distributable	11,314	109,972
Subtotal (C)	57,361	\$ 557,549
(6) Training	631	6,133
Subtotal (D)	57,992	\$ 563,682
(7) Q&RA	11,598	112,733
(8) Mfg. Tech.	1,102	13,015
Total Production Labor	70,692	\$ 689,430
Material		
(9) Raw Material & Standards		
(10) Q&RA		\$ 3,479
(11) Mfg. Tech.		1,929
Material Subtotal		\$ 5,408
(12) Material & Adm. Burden		1,839
Total Material		\$ 7,247
Total Production Cost		\$ 696,677

MLLV
PART IIB
MANUFACTURING
TOOLING
ENGINE INSTALLATION - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.1.4.0-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,828	\$ 27,488
(2) Direct Distributabel	905	8,797
Subtotal (A)	3,733	36,285
(3) Training	41	399
Subtotal (B)	3,774	36,683
(4) Q&RA	775	7,339
Total Tooling Labor	4,529	\$ 44,023
Material		
(5) Tooling		\$ 3,949
(6) Q&RA		227
Subtotal (C)		\$ 5,176
(7) Material & Adm. Burden		1,760
Total Material		6,936
Total Tooling Cost		\$ 50,959

PART II
MANUFACTURING
MANUFACTURING TEST
ENGINE INSTALLATION - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.4.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	<u>2,948</u>	<u>\$ 28,655</u>
Component Test Planning	<u>1,387</u>	<u>13,482</u>
(1) Subtotal	<u>4,335</u>	<u>\$ 42,137</u>
(2) Direct Distributable	<u>1,387</u>	<u>13,482</u>
Subtotal	<u>5,722</u>	<u>\$ 55,619</u>
(3) Training	<u>63</u>	<u>612</u>
Subtotal	<u>5,785</u>	<u>\$ 56,231</u>
(4) Mfg. Tech.	<u>110</u>	<u>1,299</u>
Subtotal	<u>5,895</u>	<u>\$ 57,530</u>
(5) Q&RA	<u>1,157</u>	<u>11,246</u>
Total Mfg. Test Labor	<u><u>7,052</u></u>	<u><u>\$ 68,776</u></u>
Material		
(6) Q&RA		<u>\$ 347</u>
(7) Mfg. Tech.		<u>193</u>
Subtotal		<u>\$ 540</u>
(8) Material & Adm. Burden		<u>184</u>
Total Material		<u><u>\$ 724</u></u>
Total Mfg. Test Cost		<u><u>\$ 69,500</u></u>

PART III
FACILITY LABOR

ENGINE INSTALLATION - S/S

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.1.4.0-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	971	\$ 9,438
TOTAL FACILITY LABOR COST	<u> </u>	<u>\$ 9,438</u>

5.1.5 Propellant, Pressurants, and Gases

Propellant costs used on the MLLV single stage vehicle were estimated for the following types of propellants: 1) LOX, 2) LH₂, 3) LN₂, 4) GH_e, and 5) GH₂. The costs were based on the requirements for one single stage vehicle.

These costs were based on current actual costs for the Saturn V. An appropriate burden was added to account for the support activities required for procurement.

TABLE 5.1.5.0-I

MLLV COST SUMMARY

PROPELLANT-SINGLE STAGE CORE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									3,287		3,287
TOTAL COST									3,287		3,287

MLLV
LAUNCH OPERATIONS
PROPELLANT
SINGLE STAGE
(IN THOUSANDS)

TABLE 5.1.5.0-II

	<u>Cubic Ft.</u>	<u>Pounds</u>	<u>Dollars</u>
LOX		13,406	\$ 168
LH ₂		2,369	1,185
LN ₂		4,800	130
GHe	15,000		936
GH ₂	3,675		<u>34</u>
Propellant Cost			\$ 2,453
Material & Admin. Burden			<u>834</u>
Total Cost			<u><u>\$ 3,287</u></u>

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5.1.6 Instrument Unit (IU)

The IU for the MLLV will be basically identified to the IU used in the Saturn V launch vehicle. The recurring costs for the MLLV Instrument Unit were, therefore, extrapolated from the Saturn V IU costs contained in the Chrysler Corporation "National Space Booster Study."

TABLE 5.1.6.0-I

MLLV COST SUMMARY INSTRUMENT UNIT - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									9,346		9,346
TOTAL COST									9,346		9,346

MLLV
 RECURRING COSTS
 INSTRUMENT UNIT
 1ST UNIT COST
 (OTHER VEHICLE)
 TABLE 5.1.6.0-II

<u>Element of Cost</u>	<u>Dollars</u> (In Thousands)
Instrument Unit	\$9,346
(1) Total Cost	<u>\$9,346</u>

(1) Cost based upon Engineering estimate.

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5.1.7 Systems Development Facility (SDF - Breadboard)

The costs for the breadboard cover that activity to:

- a. Provide for system development and evaluation of computer controlled checkout of the MLLV/Electrical Support Equipment (ESE).
- b. Develop and prove checkout techniques procedures and displays.
- c. Provide a basis for maintainability analysis.
- d. Provide personnel familiarization and training.
- e. Provide a facility where changes and modifications to the vehicle and computer controlled ESE may be evaluated.
- f. Design and evaluate many parts of the computer programs required for the checkout and launch site operations.
- g. Provide support to operational personnel at the launch site by being available to investigate any problem that may arise after the flight vehicle has been delivered to the site.
- h. Electrical simulation.

The cost information was based on the average Saturn V SDF operation cost.

TABLE 5.1.7.0-1

MLLV COST SUMMARY-SYSTEMS DEVELOPMENT FACILITY - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									6,169		6,169
TOTAL COST									6,169		6,169

MLLV
 RECURRING COST
 SYSTEMS DEVELOPMENT FACILITY
 BREADBOARD
 SINGLE STAGE
 TABLE 5.1.7.0-II

<u>Element of Cost</u>	<u>Dollars</u>
<u>Annual Operation</u>	
Engineering	\$ 1,727
Operations	4,442
	<hr/>
(1) Total Cost	\$ 6,169
	<hr/> <hr/>

(1) This Cost based on Saturn V SDF.

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5.1.8 Launch Operations

The launch operations for the single stage are divided into two parts. The first part, Table 5.1.8.0-I, represents the costs for the first and second launches which are the R&D flight tests. The second part, Table 5.1.8.0-II represents the costs for launches of the operational flight vehicles. These parts for the single stage vehicle will consist of three major categories: 1) Launch Control, 2) Launch Pad Operations, and 3) Off Site Support. Figure 5.1.8.0-1 shows the costs for each of these categories and indicates the applicable sub-sections where the costs are shown in detail. The costs reflected in this section are for the launch of one vehicle at a two per year launch rate. Costs for Launch Operations include the costs for receiving the vehicles, static firing, refurbishment of the launch pad, assembly of the vehicle, checkout, prelaunch test and checkout, servicing, launching and refurbishing of the launch pad.

They also include costs for management of the overall site operations and maintenance.

The costs do not include costs for down range operation.

LAUNCH OPERATIONS - SINGLE STAGE - 1 R&D FLIGHT VEHICLE

TABLE 5.1.8.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	179	2126								179	2,126
PROGRAM PLAN.& REPT.	442	5221								442	5,221
INDUSTRIAL RELATIONS	99	967								99	967
ENGINEERING			1195	14116						1,195	14,116
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			14731	143183						14,731	143,183
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			2845	27649						2,845	27,649
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	720	8314	18771	184948						19,491	193,262
MATERIAL				73							73
LOGISTIC HARDWARE											
BURDEN				24							24
TOTAL MATERIAL				97							97
TOTAL OTHER											
TOTAL COST		8314		185045							193,359

LAUNCH OPERATIONS - OPERATIONAL VEHICLES (THIRD VEHICLE
AND SUBSEQUENT VEHICLES)

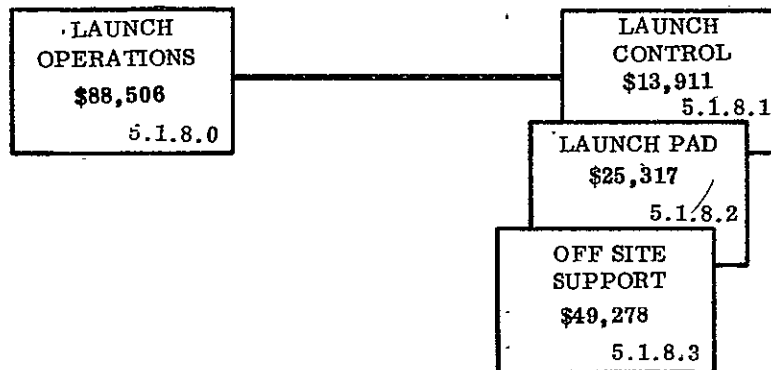
TABLE 5.1.8.0-II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

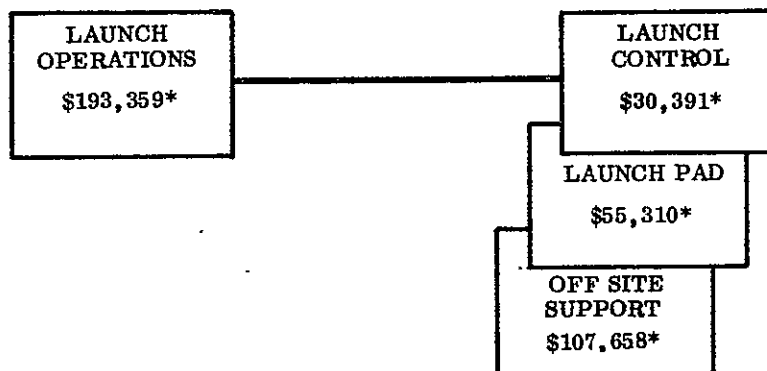
(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	82	973								82	973
PROGRAM PLAN.& REPT.	202	2390								202	2,390
INDUSTRIAL RELATIONS	45	443								45	443
ENGINEERING			547	6461						547	6,461
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			6743	65539						6,743	65,539
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1302	12656						1,302	12,656
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	329	3806	8592	84656						8,921	88,462
MATERIAL				33							33
LOGISTIC HARDWARE											
BURDEN				11							11
TOTAL MATERIAL				44							44
TOTAL OTHER											
TOTAL COST		3806		84700							88,506

FIXED COSTS - OPERATIONAL FLIGHTS (THIRD VEHICLE AND SUBSEQUENT VEHICLES)



FIXED COSTS - TWO R&D FLIGHT TEST VEHICLES (INCLUDES ADDITIONAL COSTS FOR 9 MONTH CYCLE TIME, INCREASED SE&I INSTRUMENTATION)



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

*COSTS SHOWN ABOVE
INCREASED BY A FACTOR
OF APPROXIMATELY 2.18 FOR
FLIGHT TEST VEHICLES

FIGURE 5.1.8.0-1 SINGLE STAGE LAUNCH OPERATIONS COST FLOW DIAGRAM

5.1.8.1 Launch Control Center

LAUNCH CONTROL CENTER - SINGLE STAGE - 1 R&D FLIGHT VEHICLE

TABLE 5.1.8.1-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	28	334								28	334
PROGRAM PLAN.& REPT.	70	821								70	821
INDUSTRIAL RELATIONS	16	152								16	152
ENGINEERING			188	2219						188	2,219
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			2315	22505						2,315	22,505
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			447	4345						447	4,345
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	114	1307	2950	29069						3,064	30,376
MATERIAL				11							11
LOGISTIC HARDWARE											
BURDEN				4							4
TOTAL MATERIAL				15							15
TOTAL OTHER											
TOTAL COST		1307		29084							30,391

MLLV
PART I
LAUNCH CONTROL CENTER - S/S
ASSEMBLY OR SYSTEM

CORE STAGE
TABLE 5.1.8.1-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	188		
Logistics			
Laboratory Technician			
Production	2,315		
Tooling			
Manufacturing Test			
Q&RA	447		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>2,950</u>		
Program Executive		28	334
Program Planning & Reporting		70	821
Industrial Relations		<u>16</u>	<u>152</u>
Total Labor - Part I		<u>114</u>	<u>1,307</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>1,307</u>

LAUNCH CONTROL CENTER - SINGLE STAGE

TABLE 5.1.8.1-III

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	188	2219							188	2,219
LAB TECHNICIANS										
TOOLING										
PRODUCTION			2315	22505					2,315	22,505
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			447	4345					447	4,345
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	188	2219	2762	26850						29,069
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				11						11
SUBTOTAL				11						11
MAT. & ADM. BURDEN				4						4
TOTAL MATERIAL				15						15
TOTAL PART II COST		2219		26865						29084

MLLV
 RECURRING
 LAUNCH OPERATIONS
LAUNCH CONTROL CENTER - S/S
TABLE 5.1.8.1-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	188	2,219
TOTAL COST	<u>188</u>	<u>2,219</u>

MLLV
RECURRING
LAUNCH OPERATIONS
LAUNCH CONTROL CENTER - S/S
TABLE 5.1.8.1-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	1,273	12,378
Technical Support	<u>1,042</u>	<u>10,127</u>
Subtotal	2,315	22,505
Q&RA	<u>447</u>	<u>4,345</u>
Total Labor	<u>2,762</u>	<u>26,850</u>
Material		
Q&RA		11
Material and Administrative Burden		<u>4</u>
Total Material		<u>15</u>
TOTAL COST		<u>26,865</u>

5.1.8.2 Launch Pad

LAUNCH PAD - SINGLE STAGE - 1 R&D FLIGHT VEHICLE.

TABLE 5.1.8.2-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	51	608									608
PROGRAM PLAN.& REPT.	126	1493									1,493
INDUSTRIAL RELATIONS	28	277									277
ENGINEERING			342	4038						342	4,038
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			4214	40957						4,214	40,957
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			814	7909						814	7,907
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	205	2378	4370	52904						5,370	55,282
MATERIAL				21							21
LOGISTIC HARDWARE											
BURDEN				7							7
TOTAL MATERIAL				28							28
TOTAL OTHER											
TOTAL COST		2378		52932							55,310

MLLV
PART I
LAUNCH PAD - S/S
ASSEMBLY OR SYSTEM
CORE STAGE
TABLE 5.1.8.2-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	342		
Logistics			
Laboratory Technician			
Production	4,214		
Tooling			
Manufacturing Test			
Q&RA	814		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>5,370</u>		
Program Executive		51	608
Program Planning & Reporting		126	1,493
Industrial Relations		<u>28</u>	<u>277</u>
Total Labor - Part I		<u>205</u>	<u>2,378</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>2,378</u>

LAUNCH PAD - S/S

TABLE 5.1.8.2-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	342	4038							342	4,038
LAB TECHNICIANS										
TOOLING										
PRODUCTION			4214	40957					4,214	40,957
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			814	7909					814	7,909
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	342	4039	5029	48866					5,370	52,904
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R				21						21
SUBTOTAL				21						21
MAT. & ADM. BURDEN				7						7
TOTAL MATERIAL				28						28
TOTAL PART II COST		4038		48894						52,932

MLLV
 RECURRING
 LAUNCH OPERATIONS
LAUNCH PAD - S/S
CORE STAGE
 TABLE 5.1.8.2-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	342	4,038
TOTAL COST	<u>342</u>	<u>4,038</u>

MLLV
RECURRING
LAUNCH OPERATIONS
LAUNCH PAD - S/S
CORE STAGE
TABLE 5.1.8.2-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	2,318	22,526
Technical Support	<u>1,896</u>	<u>18,431</u>
Subtotal	4,214	40,957
Q&RA	<u>814</u>	<u>7,909</u>
Total Labor	<u>5,028</u>	<u>48,866</u>
Material		
Q&RA		21
Material and Administrative Burden		<u>7</u>
Total Material		<u>28</u>
 TOTAL COST		 <u>48,894</u>

5.1.8.3 Off Site Support

OFF SITE SUPPORT COMPLEX - S/S - 1 R&D FLIGHT VEHICLES

TABLE 5.1.8.3-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	100	1184								100	1,184
PROGRAM PLAN.& REPT.	246	2907								246	2,907
INDUSTRIAL RELATIONS	55	538								55	538
ENGINEERING			665	7859						665	7,859
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			8202	79721						8,202	79,721
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			1584	15395						1,584	15,395
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	401	4629	10451	102975						10,852	107,604
MATERIAL				41							41
LOGISTIC HARDWARE											
BURDEN				13							13
TOTAL MATERIAL				54							54
TOTAL OTHER											
TOTAL COST		4629		103029							107,658

MLLV
PART I
OFF SITE SUPPORT COMPLEX - S/S
ASSEMBLY OR SYSTEM
CORE STAGE
TABLE 5.1.8.3-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	665		
Logistics			
Laboratory Technician			
Production	8,202		
Tooling			
Manufacturing Test			
Q&RA	1,584		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>10,451</u>		
Program Executive		100	1,184
Program Planning & Reporting		246	2,907
Industrial Relations		55	538
Total Labor - Part I		<u>401</u>	<u>4,629</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>4,629</u>

OFF SITE SUPPORT COMPLEX - S/S

TABLE 5.1.8.3-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	665	7859							665	7,859
LAB TECHNICIANS										
TOOLING										
PRODUCTION			8202	79721					8,202	79,721
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			1584	15395					1,584	15,395
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	665	7859	9786	95116					10,451	102,975
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				41						41
SUBTOTAL				41						41
MAT. & ADM. BURDEN				13						13
TOTAL MATERIAL				54						54
TOTAL PART II COST		7859		95170						103,029

MLLV
 RECURRING
 LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - S/S
 TABLE 5.1.8.3-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	665	7,859
TOTAL COST	<u>665</u>	<u>7,859</u>

MLLV
RECURRING
LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - S/S
TABLE 5.1.8.3-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	4,511	43,847
Technical Support	<u>3,691</u>	<u>35,874</u>
Subtotal	8,202	79,721
Q&RA	<u>1,584</u>	<u>15,395</u>
Total Labor	<u>9,786</u>	<u>95,116</u>
Material		
Q&RA		41
Material and Administrative Burden		<u>13</u>
Total Material		<u>54</u>
TOTAL COST		<u>95,170</u>

5.1.9 Launch Site Maintenance

Launch Site Maintenance includes the costs associated with brick and mortar and equipment maintenance for such items as: canals, launch pad, gantry crane, unloading crane, service structure, umbilical tower, propellant storage, transfer and disposal systems, launch and test control center and the off-site support complex.

TABLE 5.1.9.0-1
MLLV COST SUMMARY

LAUNCH FACILITY MAINTENANCE - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES						8,750					8,750
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR						8,750					8,750
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST						8,750					8,750

MLLV
 RECURRING
 *LAUNCH FACILITY MAINTENANCE
 CORE STAGE
 (IN THOUSANDS)
 TABLE 5.1.9.0-II

Brick and Monitor	\$7,000
Equipment	<u>1,750</u>
Total	<u><u>\$8,750</u></u>

*Maintenance for six (6) months or for
 one (1) vehicle.

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5.1.10 Manufacturing Facility Maintenance and Transportation

Maintenance costs include costs for maintenance of the manufacturing building, the vertical assembly building, post manufacturing and stage test building, the office building, and the capital equipment.

Transportation costs include costs for such items as the barges (for stage transportation), the tow vehicle, the land transporter, and the cost for the barge trip from the manufacturing facility to the launch site.

TABLE 5.1.10.0-I
MLLV COST SUMMARY

FACILITIES MAINTENANCE &
TRANSPORTATION - SINGLE STAGE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES						3,972					3,972
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR						3,972					3,972
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST						3,972					3,972

MLLV
NON-RECURRING COST SUMMARY

SINGLE STAGE

FACILITIES & TRANSPORTATION
(DOLLARS IN THOUSANDS)

TABLE 5.1.10.0-II

<u>Element of Cost</u>	<u>Facilities</u>	<u>Equipment</u>	<u>Transportation</u>
Manufacturing Bldg.	4,410	1,890	
Vertical Assy. Bldg.	110	47	
Post Mfg. & Stage Test Bldg.	64	37	
Liquid Engine Mfg. Bldg.			
Office	1,095	124	
Subtotal	<u>5,679</u>	<u>2,098</u>	
<u>Transportation</u>			
Barge			90
Tow Vehicle			2
Land Transporter			6
Subtotal			<u>98</u>
Totals			
Transportation			98
Equipment			2,098
Facilities			5,679
Barge Trips *			<u>70</u>
MANUFACTURING FACILITIES COST			<u>7,945</u>
Recurring Cost for one vehicle or six (6) months			<u>3,972</u>

* Barge Trips are estimated 4 per year
\$17,500 X 4 = \$70,000

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5.1.11 System Engineering and Integration (SE&I)

The Systems Engineering and Integration costs per vehicle were based on the Saturn V cost data submitted to the Chrysler Corporation in support of the "National Space Booster Study." The costs include support activity relative to:

- a. Systems Management
- b. Pre-Flight Analysis and Planning
- c. Post-Flight Data Evaluation
- d. Documentation

TABLE 5.1.11.0-I

MLLV COST SUMMARY - SYSTEMS EVALUATION & INTERGRATION-S/S

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									5,301		5,301
TOTAL COST									5,301		5,301

MLLV
 RECURRING COST
 SE&I
 SINGLE STAGE
 (DOLLARS IN THOUSANDS)
 TABLE 5.1.11.0-II

<u>Element of Cost</u>	<u>Dollars</u>
System Evaluation & Integration	\$ 5,301
(1) Total Cost	<u>\$ 5,301</u>

(1) Cost based on Saturn V

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5.2 ENGINE MODULE - INJECTION STAGE

The summary costs for the first unit injection stage - engine module are displayed in Figure 5.2.0.0-1. These costs include not only the hardware, but all the costs associated with launching the stage and maintaining that portion of the facility associated with the engine module. Table 5.2.0.0-I summarized the cost of the engine module by part and by element of costs for the first R&D flight vehicles.

Table 5.2.0.0-II displays (for reference) the costs for the first operational vehicle (third unit).

ENGINE MODULE - 1 R&D FLIGHT VEHICLES

TABLE 5.2.0.0-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	12	135								12	135
PROGRAM PLAN.& REPT.	29	340								29	340
INDUSTRIAL RELATIONS	5	59								5	59
ENGINEERING			1073	8858			19	226		1,092	9,084
LAB TECHNICIANS			27	244						27	244
TOOLING			32	525						32	525
PRODUCTION			1340	16353						1,340	16,353
MANUFACTURING TEST			28	446						26	446
MANUFACTURING TECH.			12	160						12	160
Q & R A			154	1530						154	1,530
FACILITIES					12	1434				12	1,434
DIRECT DIST			154	1478						154	1,478
TRAINING			8	82						8	82
TOTAL DIRECT LABCR	46	534	2828	29676	12	1434	19	226		2,905	31,870
MATERIAL				1800							1,800
LOGISTIC HARDWARE								1071			1,071
BURDEN				576				365			941
TOTAL MATERIAL				2376				1436			3,812
TOTAL OTHER									365		365
TOTAL COST		534		32052		1434		1662	365		36,047

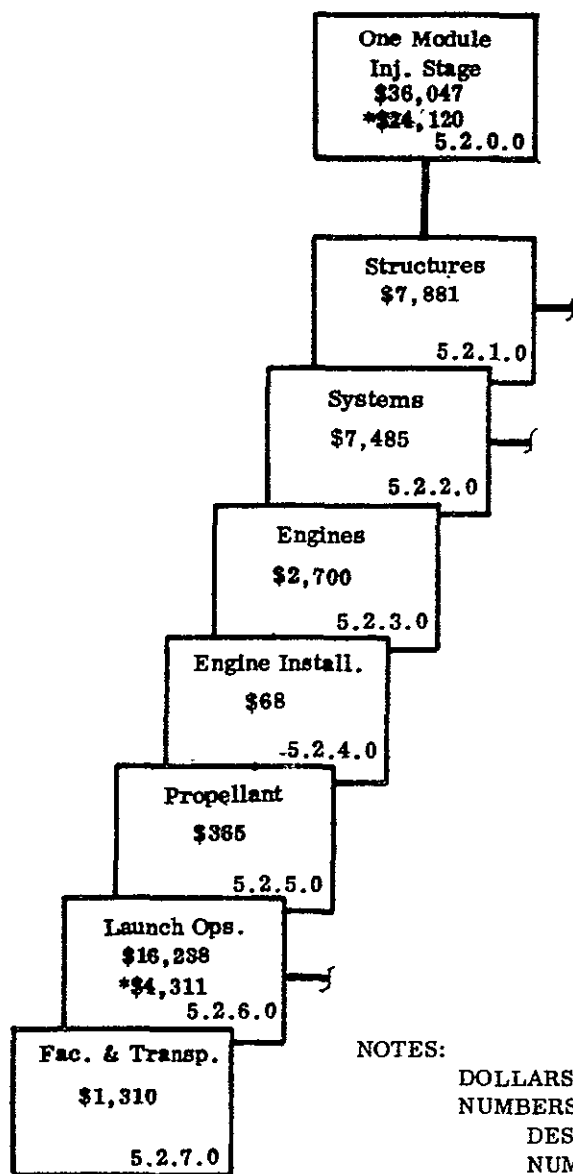
**ENGINE MODULE - OPERATIONAL VEHICLES
(THIRD VEHICLE AND SUBSEQUENT VEHICLES)**

**TABLE 5.2.0.0-II
MLLV COST SUMMARY**

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	12	135								12	135
PROGRAM PLAN.& REPT.	29	340								29	340
INDUSTRIAL RELATIONS	5	59								5	59
ENGINEERING			393	3521			19	226		412	3,747
LAB TECHNICIANS			27	244						27	244
TOOLING			32	525						32	525
PRODUCTION			875	9835						875	9,835
MANUFACTURING TEST			28	446						28	446
MANUFACTURING TECH.			12	160						12	160
Q & R A			154	1530						154	1,530
FACILITIES					12	1434				12	1,434
DIRECT DIST			154	1478						154	1,478
TRAINING			148	82						148	82
TOTAL DIRECT LABOR	46	534	1823	17821	12	1434	19	226		1,900	20,015
MATERIAL				1728							1,728
LOGISTIC HARDWARE								1071			1,071
BURDEN				576				365			941
TOTAL MATERIAL				2304				1436			3,740
TOTAL OTHER									365		365
TOTAL COST		534		20125		1434		1662	365		24,120



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

*FIRST OPERATIONAL UNIT COST WHICH DIFFERS
SIGNIFICANTLY FROM THOSE OF FIRST R&D FLIGHT
UNIT

FIGURE 5.2.0.0-1 ENGINE MODULE INJECTION STAGE COST FLOW DIAGRAM

5.2.1 Structures - Injection Stage Engine Module

The first unit production cost for the structural components of the engine module are displayed in Figure 5.2.1.0-1. The cost details of the structural components are contained in appropriate subparagraphs as indicated. Table 5.1.1.0-I is a total cost summary of these structures.

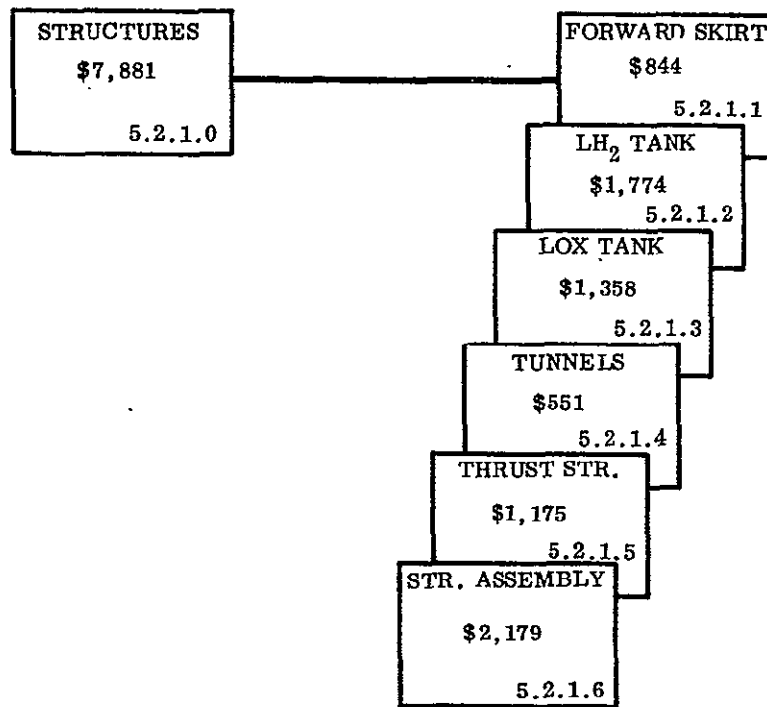
TABLE 5.2.1.0-I

MLLV COST SUMMARY TOTAL STRUCTURE-ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	7	73								7	73
PROGRAM PLAN. & REPT.	16	185								16	185
INDUSTRIAL RELATIONS	3	32								3	32
ENGINEERING			70	814			11	123		81	937
LAB TECHNICIANS			15	133						15	133
TOOLING			17	177						17	177
PRODUCTION			295	2,869						295	2,869
MANUFACTURING TEST			14	135						14	135
MANUFACTURING TECH.			7	87						7	87
Q & R A			83	830						83	830
FACILITIES					7	67				7	67
DIRECT DIST			84	803						84	803
TRAINING			5	44						5	44
TOTAL DIRECT LABOR	26	\$290	590	\$5,892	7	\$67	11	\$123		634	\$6,372
MATERIAL				540							540
LOGISTIC HARDWARE								586			586
BURDEN				182				201			383
TOTAL MATERIAL				\$722				\$787			\$1,509
TOTAL OTHER											
TOTAL COST		\$290		\$6,614		\$67		\$910			\$7,881



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 5.2.1.0-1 ENGINE MODULE STRUCTURES COST FLOW DIAGRAM

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5.2.1.1 Forward Skirt - Injection Stage Engine Module

TABLE 5.2.1.1-I

MLLV COST SUMMARY FORWARD SKIRT - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	7								1	7
PROGRAM PLAN. & REPT.	2	19								2	19
INDUSTRIAL RELATIONS		3									3
ENGINEERING			2	20				3		2	23
LAB TECHNICIANS				3							3
TOOLING			2	21						2	21
PRODUCTION			35	338						35	338
MANUFACTURING TEST			2	16						2	16
MANUFACTURING TECH.			1	10						1	10
Q & R A			9	95						9	95
FACILITIES					1	8				1	8
DIRECT DIST			10	95						10	95
TRAINING			1	5						1	5
TOTAL DIRECT LABOR	3	\$29	62	\$603	1	\$8		\$3		66	\$643
MATERIAL				136							136
LOGISTIC HARDWARE								14			14
BURDEN				46				5			51
TOTAL MATERIAL				\$182				\$19			\$201
TOTAL OTHER											
TOTAL COST		\$29		\$785		\$8		\$22			\$844

MLLV

PART I

FORWARD SKIRT-E/M
ASSEMBLY OR SYSTEM

TABLE 5.2.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	1,661		
Logistics	251		
Laboratory Technician	332		
Production	34,790		
Tooling	2,137		
Manufacturing Test	1,618		
Q&RA	9,831		
Facilities	801		
Manufacturing Technician	873		
Total Direct Labor	52,294		
Program Executive		628	\$ 7,411
Program Planning & Reporting		1,569	18,528
Industrial Relations		340	3,304
Total Labor - Part I		2,537	\$29,243
<u>Material</u>			
Program Planning & Reporting			31
Industrial Relations			34
Material Subtotal			65
Material & Administrative Burden			22
Total Material			87
TOTAL COST - PART I			\$29,330

TABLE 5.2.1.1-III

MLLV PART II COST SUMMARY FORWARD SKIRT - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	2	19							2	19
LAB TECHNICIANS		3								3
TOOLING					2	21			2	21
PRODUCTION			35	338					35	338
MANUFACTURING TEST							2	16	2	16
MANUFACTURING TECH.			1	10				1	1	11
Q & R A		1	9	85	1	6		4	10	96
DIRECT DIST			9	83	1	7	1	5	11	95
TRAINING				5						5
TOTAL DIRECT LABOR	2	23	54	521	4	34	3	26	63	604
MATERIAL										
LAB. TECHNICIANS		1								1
TOOLING						4				4
PRODUCTION				127						127
MFG. TECHNICIANS				1						1
Q & R A				2						2
SUBTOTAL		1		130		4				135
MAT. & ADM. BURDEN				45		1				46
TOTAL MATERIAL		1		175		5				181
TOTAL PART II COST		24		696		39		26		785

MLLV
PART II
ENGINEERING

FORWARD SKIRT - EM
ASSEMBLY OR SYSTEM

TABLE 5.2.1.1-IV

<u>Element of Cost .</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	<u>1,627</u>	<u>\$19,215</u>
Reliability Engineering	<u>34</u>	<u>401</u>
(1) Subtotal	1,661	19,616
(2) Laboratory Technicians	<u>332</u>	<u>3,227</u>
Subtotal	1,993	22,843
(3) Q&RA	<u>66</u>	<u>642</u>
Total Engineering Labor	<u><u>2,059</u></u>	<u><u>\$23,485</u></u>
Material		
(4) Lab. Tech.		<u>\$ 697</u>
(5) Q&RA		<u>20</u>
Subtotal		717
(6) Material & Adm. Burden		<u>244</u>
Total Material		<u><u>961</u></u>
Total Engineering Cost		<u><u>\$24,446</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION

FORWARD SKIRT - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>24,529</u>	\$ <u>238,422</u>
(2) Miscellaneous Charges	<u>1,913</u>	<u>18,596</u>
(3) Maintain & Add in Scope Changes	<u>270</u>	<u>2,622</u>
Subtotal	26,712	259,641
(4) Tool & Production Planning	<u>8,078</u>	<u>78,515</u>
Subtotal	34,790	338,156
(5) Direct Distributable	<u>8,548</u>	<u>83,085</u>
Subtotal	43,338	421,240
(6) Training	<u>477</u>	<u>4,634</u>
Subtotal	43,814	425,874
(7) Q&RA	<u>8,763</u>	<u>85,174</u>
(8) Mfg. Tech.	<u>832</u>	<u>9,831</u>
Total Production Labor	<u>53,409</u>	\$ <u>520,879</u>
Material		
(9) Raw Material & Standards		\$ <u>126,876</u>
(10) Q&RA		<u>2,629</u>
(11) Mfg. Tech.		<u>1,457</u>
Material Subtotal		130,962
(12) Material & Adm. Burden		<u>44,527</u>
Total Material		<u>175,488</u>
Total Production Cost		\$ <u>696,367</u>

MLLV
PART II
MANUFACTURING
TOOLING

FORWARD SKIRT - EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,137	\$ 20,772
(2) Direct Distributable	684	6,647
Subtotal	2,821	27,418
(3) Training	31	301
Subtotal	2,852	27,719
(4) Q&RA	570	5,543
Total Tooling Labor	3,422	\$ 33,262
Material		
(5) Tooling		\$ 3,740
(6) Q&RA		170
Subtotal		3,910
(7) Material & Adm. Burden		1,330
Total Material		5,240
Total Tooling Cost		\$ 38,502

PART II
MANUFACTURING
MANUFACTURING TEST

FORWARD SKIRT - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,226	\$11,917
Component Test Planning	392	3,813
(1) Subtotal (A)	1,618	15,730
(2) Direct Distributable	518	5,033
Subtotal (B)	2,136	20,763
(3) Training	23	227
Subtotal (C)	2,159	20,990
(4) Mfg. Tech.	41	484
Subtotal (D)	2,200	21,474
(5) Q&RA	432	4,198
Total Mfg. Test Labor	2,632	25,672
Material		
(6) Q&RA		130
(7) Mfg. Tech.		72
Subtotal (E)		202
(8) Material & Adm. Burden		68
Total Material		270
Total Mfg. Test Cost		\$25,942

MLLV
PART III
FACILITY LABOR

FORWARD SKIRT - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE: 5.2.1.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	801	\$7,786
TOTAL FACILITY LABOR COST	<u>801</u>	<u>\$7,786</u>

MLLV
PART IV
LOGISTIC LABOR

FORWARD SKIRT - EM

ASSEMBLY OR SYSTEM

TABLE 5.2.1.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>251</u>	<u>\$ 2,964</u>
(2) Hardware	<u></u>	<u>14,056</u>
(3) Material & Adm. Burden	<u></u>	<u>4,779</u>
Total Material	<u></u>	<u>\$18,835</u>
Total Logistic Cost	<u></u>	<u>\$21,799</u>

5.2.1.2 LH₂ Tank - Injection Stage Engine Module

TABLE 5.2.1.2-I

MLLV COST SUMMARY

LH₂ TANK - ENGINE MODULEA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	17								1	17
PROGRAM PLAN. & REPT.	4	42								4	42
INDUSTRIAL RELATIONS	1	7								1	7
ENGINEERING			13	147			2	22		15	169
LAB TECHNICIANS			3	24						3	24
TOOLING			4	42						4	42
PRODUCTION			70	684						70	684
MANUFACTURING TEST			3	32						3	32
MANUFACTURING TECH.			2	21						2	21
Q & R A			20	197						20	197
FACILITIES					2	16				2	16
DIRECT DIST			20	191						20	191
TRAINING			1	10						1	10
TOTAL DIRECT LABOR	6	\$66	136	\$1,348	2	\$16	2	\$22		146	\$1,452
MATERIAL				135							135
LOGISTIC HARDWARE								105			105
BURDEN				46				36			82
TOTAL MATERIAL				\$ 181				\$141			322
TOTAL OTHER											
TOTAL COST		\$66		\$1,529		\$16		\$163			\$1,774

MLLV

PART I

LH₂ TANK - E/M
ASSEMBLY OR SYSTEM

TABLE 5.2.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	12,461		
Logistics	1,879		
Laboratory Technician	2,492		
Production	70,326		
Tooling	4,320		
Manufacturing Test	3,272		
Q&RA	20,238		
Facilities	1,620		
Manufacturing Technician	<u>1,766</u>		
Total Direct Labor	<u>118,374</u>		
Program Executive		1,420	\$16,775
Program Planning & Reporting		3,551	41,940
Industrial Relations		<u>769</u>	<u>7,479</u>
Total Labor - Part I		<u>5,740</u>	<u>\$66,194</u>
<u>Material</u>			
Program Planning & Reporting			71
Industrial Relations			<u>77</u>
Material Subtotal			148
Material & Administrative Burden			<u>50</u>
Total Material			<u>198</u>
TOTAL COST - PART I			<u>\$66,392</u>

TABLE 5.2.1.2-III

MLLV PART II COST SUMMARY

LH₂ TANK - E/MA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	12	147							12	147
LAB TECHNICIANS	2	24							2	24
TOOLING					4	42			4	42
PRODUCTION			70	684					70	684
MANUFACTURING TEST							3	32	3	32
MANUFACTURING TECH.			2	20				1	2	21
Q & R A	1	5	18	172	1	11	1	9	21	197
DIRECT DIST			17	168	2	13	1	10	20	191
TRAINING			1	9		1		1	1	11
TOTAL DIRECT LABOR	15	176	108	1,053	7	67	5	53	135	1,349
MATERIAL										
LAB. TECHNICIANS		5								5
TOOLING						8				8
PRODUCTION				113						113
MFG. TECHNICIANS				3						3
Q & R A				5						5
SUBTOTAL		5		121		8				134
MAT. & ADM. EXPEN		2		41		3				46
TOTAL MATERIAL		7		162		11				180
TOTAL PART II COST		183		1,215		78		52		1,529

MLLV
PART II
ENGINEERING

LH₂ TANK -EM
ASSEMBLY OR SYSTEM
TABLE 5.2.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	<u>12,203</u>	<u>\$144,117</u>
Reliability Engineering	<u>258</u>	<u>3,047</u>
(1) Subtotal	12,461	147,164
(2) Laboratory Technicians	<u>2,492</u>	<u>24,222</u>
Subtotal	14,953	171,386
(3) Q&RA	<u>498</u>	<u>4,841</u>
Total Engineering Labor	<u>15,451</u>	<u>\$176,227</u>
Material		
(4) Lab. Tech.		<u>\$ 5,233</u>
(5) Q&RA		<u>149</u>
Subtotal		5,382
(6) Material & Adm. Burden		<u>1,830</u>
Total Material		<u>7,212</u>
Total Engineering Cost		<u>\$183,349</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

LH₂ TANK-EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>49,584</u>	\$ <u>481,956</u>
(2) Miscellaneous Charges	<u>3,868</u>	<u>37,592</u>
(3) Maintain & Add in Scope Changes	<u>545</u>	<u>5,301</u>
Subtotal	53,997	524,850
(4) Tool & Production Planning	<u>16,329</u>	<u>158,714</u>
Subtotal	70,326	683,564
(5) Direct Distributable	<u>17,279</u>	<u>167,952</u>
Subtotal	87,605	851,515
(6) Training	<u>964</u>	<u>9,366</u>
Subtotal	88,568	860,882
(7) Q&RA	<u>17,714</u>	<u>172,176</u>
(8) Mfg. Tech.	<u>1,683</u>	<u>19,873</u>
Total Production Labor	<u>107,964</u>	<u>\$1,052,930</u>
Material		
(9) Raw Material & Standards		\$ <u>112,833</u>
(10) Q&RA		<u>5,314</u>
(11) Mfg. Tech.		<u>2,945</u>
Material Subtotal		121,092
(12) Material & Adm. Burden		<u>41,172</u>
Total Material		<u>162,263</u>
Total Production Cost		<u>\$1,215,193</u>

MLLV
PART II
MANUFACTURING
TOOLING

LH₂ TANK -EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>4,320</u>	<u>\$ 41,990</u>
(2) Direct Distributable	<u>1,382</u>	<u>13,437</u>
Subtotal	<u>5,702</u>	<u>55,427</u>
(3) Training	<u>63</u>	<u>609</u>
Subtotal	<u>5,765</u>	<u>56,036</u>
(4) Q&RA	<u>1,153</u>	<u>11,207</u>
Total Tooling Labor	<u><u>6,918</u></u>	<u><u>\$ 67,243</u></u>
Material		
(5) Tooling		<u>7,560</u>
(6) Q&RA		<u>346</u>
Subtotal		<u>7,906</u>
(7) Material & Adm. Burden		<u>2,688</u>
Total Material		<u>10,594</u>
Total Tooling Cost		<u><u>\$ 77,837</u></u>

PART II
MANUFACTURING
MANUFACTURING TEST

LH₂ TANK-EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	2,479	\$24,096
Component Test Planning	793	7,710
(1) Subtotal (A)	3,272	31,806
(2) Direct Distributable	1,047	10,178
Subtotal (B)	4,319	41,984
(3) Training	48	462
Subtotal (C)	4,367	42,446
(4) Mfg. Tech.	83	979
Subtotal (D)	4,450	43,424
(5) Q&RA	873	8,488
Total Mfg. Test Labor	5,323	\$51,912
Material		
(6) Q&RA		262
(7) Mfg. Tech.		145
Subtotal (E)		407
(8) Material & Adm. Burden		138
Total Material		545
Total Mfg. Test Cost		\$52,457

MLLV
PART III
FACILITY LABOR

LH₂ TANK -EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.2-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,620	\$15,746
TOTAL FACILITY LABOR COST	<u>1,620</u>	<u>\$15,746</u>

MLLV
PART IV
LOGISTIC LABOR

LH₂ TANK --EM

ASSEMBLY OR SYSTEM

TABLE 5.2.1.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,879</u>	<u>\$ 22,191</u>
(2) Hardware	<u> </u>	<u>105,224</u>
(3) Material & Adm. Burden	<u> </u>	<u>35,776</u>
Total Material	<u> </u>	<u>\$141,000</u>
Total Logistic Cost	<u> </u>	<u>\$163,191</u>

5.2.1.3 LOX Tank - Injection Stage Engine Module

TABLE 5.2.1.3-I

MLLV COST SUMMARY LOX TANK - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	13								1	13
PROGRAM PLAN. & REPT.	3	33								3	33
INDUSTRIAL RELATIONS	1	6								1	6
ENGINEERING			13	147			2	22		15	169
LAB TECHNICIANS			3	24						3	24
TOOLING			3	32						3	32
PRODUCTION			53	514						53	514
MANUFACTURING TEST			2	24						2	24
MANUFACTURING TECH.			1	16						1	16
Q & R A			15	149						15	149
FACILITIES					1	12				1	12
DIRECT DIST			15	144						15	144
TRAINING			1	8						1	8
TOTAL DIRECT LABOR	5	\$42	106	\$1,058	1	\$12	2	\$22		114	\$1,144
MATERIAL				55							55
LOGISTIC HARDWARE								105			105
BURDEN				18				36			54
TOTAL MATERIAL				\$ 73				\$141			\$ 214
TOTAL OTHER											
TOTAL COST		\$52		\$1,131		\$12		\$163			\$1,358

MLLV

PART I

LOX TANK
ASSEMBLY OR SYSTEM

TABLE 5.2.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	12,461		
Logistics	1,879		
Laboratory Technician	2,492		
Production	52,880		
Tooling	3,248		
Manufacturing Test	2,460		
Q&RA	15,342		
Facilities	1,218		
Manufacturing Technician	1,327		
Total Direct Labor	<u>93,307</u>		
Program Executive		1,120	13,222
Program Planning & Reporting		2,799	33,059
Industrial Relations		<u>606</u>	<u>5,894</u>
Total Labor - Part I		<u>4,525</u>	<u>\$52,175</u>
<u>Material</u>			
Program Planning & Reporting			56
Industrial Relations			61
Material Subtotal			117
Material & Administrative Burden			<u>40</u>
Total Material			<u>157</u>
TOTAL COST - PART I			<u>\$52,332</u>

TABLE 5.2.1.3-III

MLLV PART II COST SUMMARY

LOX TANK - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	12	147							12	147
LAB TECHNICIANS	2	24							2	24
TOOLING					3	32			3	32
PRODUCTION			53	514					53	514
MANUFACTURING TEST							2	24	2	24
MANUFACTURING TECH.			1	15				1	1	16
Q & R A	1	5	13	130	1	8	1	6	16	149
DIRECT DIST			13	126	1	10	1	8	15	144
TRAINING			1	7	1	1			1	8
TOTAL DIRECT LABOR	15	176	81	792	5	51	4	39	105	1,058
MATERIAL										
LAB. TECHNICIANS		5								5
TOOLING						6				6
PRODUCTION				37						37
MFG. TECHNICIANS				2						2
Q & R A				4						4
SUBTOTAL		5		43		6				54
MAT. & ADM. BURDEN		2		15		2				19
TOTAL MATERIAL		7		58		8				73
TOTAL PART II COST		183		850		59		39		1,131

MLLV
PART II
ENGINEERING

LOX TANK -EM
ASSEMBLY OR SYSTEM

TABLE 5.2.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	12,203	144,117
Reliability Engineering	<u>258</u>	<u>3,047</u>
(1) Subtotal	12,461	147,164
(2) Laboratory Technicians	<u>2,492</u>	<u>24,222</u>
Subtotal	14,953	171,386
(3) Q&RA	<u>498</u>	<u>4,841</u>
Total Engineering Labor	<u>15,451</u>	<u>\$176,227</u>
Material		
(4) Lab. Tech.		\$ 5,233
(5) Q&RA		<u>149</u>
Subtotal		5,382
(6) Material & Adm. Burden		<u>1,830</u>
Total Material		<u>7,212</u>
Total Engineering Cost		<u>\$183,349</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

LOX TANK -EM
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>37,284</u>	\$ <u>362,400</u>
(2) Miscellaneous Charges	<u>2,908</u>	<u>28,267</u>
(3) Maintain & Add in Scope Changes	<u>410</u>	<u>3,986</u>
Subtotal	40,602	394,653
(4) Tool & Production Planning	<u>12,278</u>	<u>119,343</u>
Subtotal	52,880	513,996
(5) Direct Distributable	<u>12,993</u>	<u>126,289</u>
Subtotal	65,873	640,285
(6) Training	<u>725</u>	<u>7,043</u>
Subtotal	66,598	647,328
(7) Q&RA	<u>13,320</u>	<u>129,466</u>
(8) Mfg. Tech.	<u>1,265</u>	<u>14,943</u>
Total Production Labor	<u>81,182</u>	\$ <u>791,737</u>
Material		
(9) Raw Material & Standards		\$ <u>37,137</u>
(10) Q&RA		<u>3,996</u>
(11) Mfg. Tech.		<u>2,214</u>
Material Subtotal		43,347
(12) Material & Adm. Burden		<u>14,738</u>
Total Material		<u>58,085</u>
Total Production Cost		\$ <u>849,822</u>

MLLV
PART II
MANUFACTURING
TOOLING

LOX TANK - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>3,248</u>	\$ <u>31,571</u>
(2) Direct Distributable	<u>1,039</u>	<u>10,102</u>
Subtotal	<u>4,287</u>	<u>41,673</u>
(3) Training	<u>47</u>	<u>458</u>
Subtotal	<u>4,334</u>	<u>42,131</u>
(4) Q&RA	<u>867</u>	<u>8,425</u>
Total Tooling Labor	<u><u>5,201</u></u>	\$ <u><u>50,556</u></u>
Material		
(5) Tooling		<u>5,684</u>
(6) Q&RA		<u>260</u>
Subtotal		<u>5,944</u>
(7) Material & Adm. Burden		<u>2,021</u>
Total Material		<u><u>7,965</u></u>
Total Tooling Cost		\$ <u><u>58,521</u></u>

MLLV
PART II:
MANUFACTURING
MANUFACTURING TEST

LOX TANK-EM
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,864	18,118
Component Test Planning	596	5,797
(1) Subtotal (A)	2,460	23,915
(2) Direct Distributable	787	7,653
Subtotal (B)	3,247	31,568
(3) Training	36	347
Subtotal (C)	3,293	31,915
(4) Mfg. Tech.	62	736
Subtotal (D)	3,345	32,651
(5) Q&RA	657	6,382
Total Mfg. Test Labor	4,002	39,033
Material		
(6) Q&RA		197
(7) Mfg. Tech.		109
Subtotal (E)		306
(8) Material & Adm. Burden		104
Total Material		410
Total Mfg. Test Cost		\$39,443

MLLV
PART III
FACILITY LABOR

LOX TANK -EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,218	\$11,839
TOTAL FACILITY LABOR COST	<u>1,218</u>	<u>\$11,839</u>

MLLV
PART IV
LOGISTIC LABOR
LOX TANK-EM
ASSEMBLY OR SYSTEM
TABLE 5.2.1.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,879</u>	<u>\$ 22,191</u>
(2) Hardware	<u> </u>	<u>105,224</u>
(3) Material & Adm. Burden	<u> </u>	<u>35,776</u>
Total Material	<u> </u>	<u>\$141,000</u>
Total Logistic Cost	<u> </u>	<u>\$163,191</u>

5.2.1.4 Tunnels - Injection Stage Engine Module

TABLE 5.2.1.4-I

MLLV COST SUMMARY

TUNNELS - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	5								1	5
PROGRAM PLAN. & REPT.	1	13								1	13
INDUSTRIAL RELATIONS		2									2
ENGINEERING			8	98			1	15		4	113
LAB TECHNICIANS			2	16						2	16
TOOLING			1	10						1	10
PRODUCTION			17	165						17	165
MANUFACTURING TEST			1	8						1	8
MANUFACTURING TECH.				5						5	5
Q & R A			5	49						5	49
FACILITIES					4						4
DIRECT DIST			5	46						5	46
TRAINING				3							3
TOTAL DIRECT LABOR	2	\$20	39	400		\$4	1	\$ 15		37	\$439
MATERIAL				13							13
LOGISTIC HARDWARE								70			70
BURDEN				5				24			29
TOTAL MATERIAL				\$18				\$ 94			\$112
TOTAL OTHER											
TOTAL COST		\$20		\$418		\$4		\$109			\$551

MLLV
RECURRING
PART I
TUNNELS - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	8,308		
Logistics	1,252		
Laboratory Technician	1,662		
Production	16,977		
Tooling	1,043		
Manufacturing Test	791		
Q&RA	5,097		
Facilities	391		
Manufacturing Technician	426		
Total Direct Labor	35,947		
Program Executive		431	\$ 5,094
Program Planning & Reporting		1,078	12,736
Industrial Relations		234	2,271
Total Labor - Part I		1,743	\$20,101
<u>Material</u>			
Program Planning & Reporting			22
Industrial Relations			23
Material Subtotal			45
Material & Administrative Burden			15
Total Material			60
TOTAL COST - PART I			\$20,161

TABLE 5.2.1.4-III

MLLV PART II COST SUMMARY TUNNELS - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	8	98							8	98
LAB TECHNICIANS	2	16							2	16
TOOLING					1	10			1	10
PRODUCTION			17	165					17	165
MANUFACTURING TEST							1	8	1	8
MANUFACTURING TECH.			1	5				1	1	6
Q & R A		3	4	41		3		2	4	49
DIRECT DIST			4	41	1	3		2	5	46
TRAINING				2						2
TOTAL DIRECT LABOR	10	117	26	254	2	16	1	13		400
MATERIAL										
LAB. TECHNICIANS		3								3
TOOLING				6		2				8
PRODUCTION				1						1
MFG. TECHNICIANS										
Q & R A				1						1
SUBTOTAL		3		8		2				13
MAT. & ADM. BURDEN		1		3		1				5
TOTAL MATERIAL		4		11		3				18
TOTAL PART II COST		121		265		19		13		418

MLLV
PART II
ENGINEERING

TUNNELS - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.1.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	<u>8,136</u>	<u>\$ 96,086</u>
Reliability Engineering	<u>172</u>	<u>2.031</u>
(1) Subtotal	<u>8,308</u>	<u>98,117</u>
(2) Laboratory Technicians	<u>1,662</u>	<u>16,155</u>
Subtotal	<u>9,965</u>	<u>114,273</u>
(3) Q&RA	<u>332</u>	<u>3,227</u>
Total Engineering Labor	<u><u>10,297</u></u>	<u><u>\$117,500</u></u>
Material		
(4) Lab. Tech.		<u>\$ 3,490</u>
(5) Q&RA		<u>100</u>
Subtotal		<u>3,590</u>
(6) Material & Adm. Burden		<u>1,221</u>
Total Material		<u><u>4,811</u></u>
Total Engineering Cost		<u><u>\$122,312</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION

TUNNELS -EM

ASSEMBLY OR SYSTEM
1ST UNIT COST.

TABLE 5.2.1.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>11,970</u>	\$ <u>116,348</u>
(2) Miscellaneous Charges	<u>934</u>	<u>9,075</u>
(3) Maintain & Add in Scope Changes	<u>132</u>	<u>1,279</u>
Subtotal	13,035	126,702
(4) Tool & Production Planning	<u>3,942</u>	<u>38,314</u>
Subtotal	16,977	165,016
(5) Direct Distributable	<u>4,171</u>	<u>40,544</u>
Subtotal	21,148	205,560
(6) Training	<u>233</u>	<u>2,261</u>
Subtotal	21,381	207,821
(7) Q&RA	<u>4,276</u>	<u>41,564</u>
(8) Mfg. Tech.	<u>406</u>	<u>4,797</u>
Total Production Labor	<u>26,063</u>	\$ <u>254,182</u>
Material		
(9) Raw Material & Standards		\$ <u>5,716</u>
(10) Q&RA		<u>1,283</u>
(11) Mfg. Tech.		<u>711</u>
Material Subtotal		7,710
(12) Material & Adm. Burden		<u>2,621</u>
Total Material		<u>10,331</u>
Total Production Cost		\$ <u>264,513</u>

MLIV
PART II
MANUFACTURING
TOOLING

TUNNELS -EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>1,043</u>	\$ <u>10,138</u>
(2) Direct Distributable	<u>334</u>	<u>3,243</u>
Subtotal	1,377	13,381
(3) Training	<u>15</u>	<u>147</u>
Subtotal	1,392	13,528
(4) Q&RA	<u>278</u>	<u>2,705</u>
Total Tooling Labor	<u>1,670</u>	\$ <u>16,233</u>
Material		
(5) Tooling		\$ <u>1,825</u>
(6) Q&RA		<u>84</u>
Subtotal		1,909
(7) Material & Adm. Burden		<u>649</u>
Total Material		<u>2,558</u>
Total Tooling Cost		\$ <u>18,791</u>

PART II
MANUFACTURING
MANUFACTURING TEST

TUNNELS - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	599	\$ 5,822
Component Test Planning	192	1,862
(1) Subtotal (A)	791	7,684
(2) Direct Distributable	253	2,458
Subtotal (B)	1,044	10,142
(3) Training	11	111
Subtotal (C)	1,055	10,253
(4) Mfg. Tech.	20	236
Subtotal (D)	1,075	10,489
(5) Q&RA	211	2,050
Total Mfg. Test Labor	<u>1,286</u>	<u>\$12,539</u>
Material		
(6) Q&RA		63
(7) Mfg. Tech.		35
Subtotal (E)		98
(8) Material & Adm. Burden		33
Total Material		<u>131</u>
Total Mfg. Test Cost		<u>\$12,670</u>

MLLV
PART III
FACILITY LABOR

TUNNELS - EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	391	\$3,800
TOTAL FACILITY LABOR COST	<u>391</u>	<u>\$3,800</u>

MLLV
PART IV
LOGISTIC LABOR
TUNNELS - EM
ASSEMBLY OR SYSTEM
TABLE 5.2.1.4-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,252</u>	<u>\$ 14,786</u>
(2) Hardware	<u> </u>	<u>70,112</u>
(3) Material & Adm. Burden	<u> </u>	<u>23,838</u>
Total Material	<u> </u>	<u>93,950</u>
Total Logistic Cost	<u> </u>	<u>\$108,736</u>

5.2.1.5 Thrust Structure - Injection Stage Engine Module

TABLE 5.2.1.5-I

MLLV COST SUMMARY

THRUST STRUCTURE - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	10								1	10
PROGRAM PLAN. & REPT.	2	24								2	24
INDUSTRIAL RELATIONS		4									4
ENGINEERING			10	123			2	18		12	141
LAB TECHNICIANS			2	20						2	20
TOOLING			2	22						2	22
PRODUCTION			37	360						37	360
MANUFACTURING TEST			2	17						2	17
MANUFACTURING TECH.			1	11						1	11
Q & R A			11	105						11	105
FACILITIES					1	8				1	8
DIRECT DIST			10	101						10	101
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	3	\$38	76	\$765	1	\$8	2	\$18		82	\$829
MATERIAL				170							170
LOGISTIC HARDWARE								88			88
BURDEN				58				30			88
TOTAL MATERIAL				\$228				\$118			\$346
TOTAL OTHER											
TOTAL COST		\$38	\$993			\$8		\$136			\$1,175

MLLV

PART I

THRUST STRUCTURE
ASSEMBLY OR SYSTEM

TABLE 5.2.1.5-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	10,428		
Logistics	1,572		
Laboratory Technician	2,086		
Production	37,016		
Tooling	2,274		
Manufacturing Test	1,723		
Q&RA	10,808		
Facilities	853		
Manufacturing Technician	<u>930</u>		
Total Direct Labor	<u>67,690</u>		
Program Executive		812	9,592
Program Planning & Reporting		2,031	23,983
Industrial Relations		<u>440</u>	<u>4,276</u>
Total Labor - Part I		<u>3,283</u>	<u>\$37,851</u>
<u>Material</u>			
Program Planning & Reporting			41
Industrial Relations			44
Material Subtotal			85
Material & Administrative Burden			<u>29</u>
Total Material			<u>114</u>
TOTAL COST - PART I			<u>\$37,965</u>

TABLE 5.2.1.5-III

MLLV PART II COST SUMMARY THRUST STRUCTURE - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	10	123							10	123
LAB TECHNICIANS	2	21							2	21
TOOLING					3	22			2	22
PRODUCTION			37	360					37	360
MANUFACTURING TEST							2	17	2	17
MANUFACTURING TECH.			1	10				1	1	11
Q & R A	1	4	9	91	1	6		5	11	106
DIRECT DIST			9	88	1	7	1	5	11	100
TRAINING			1	5					1	5
TOTAL DIRECT LABOR	13	148	57	554	4	35	3	28	77	765
MATERIAL										
LAB. TECHNICIANS		4								5
TOOLING						4				4
PRODUCTION				157						157
MFG. TECHNICIANS				7						2
Q & R A				3						3
SUBTOTAL		4		162		4				171
MAT. & ADM. BURDEN		1		55		2				57
TOTAL MATERIAL		5		217		6				228
TOTAL PART II COST		153		771		41		28		993

PART II
ENGINEERING

THRUST STRUCTURE-EM

ASSEMBLY OR SYSTEM

TABLE 5.2.1.5-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	10,212	\$120,604
Reliability Engineering	216	2,551
(1) Subtotal (A)	10,428	123,155
(2) Laboratory Technicians	2,086	20,276
Subtotal (B)	12,514	143,431
(3) Q&RA	417	4,053
Total Engineering Labor	12,931	\$147,484
Material		
(4) Lab. Tech.		\$ 4,381
(5) Q&RA		125
Subtotal (C)		4,506
(6) Material & Adm. Burden		1,532
Total Material		6,038
Total Engineering Cost		\$153,522

PART II
MANUFACTURING
PRODUCTION
THRUST STRUCTURE - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.5-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	26,099	\$253,682
(2) Miscellaneous Charges	2,036	19,787
(3) Maintain & Add in Scope Changes	287	2,790
Subtotal (A)	28,422	276,259
(4) Tool & Production Planning	8,595	83,540
Subtotal (B)	37,016	359,799
(5) Direct Distributable	9,095	88,402
Subtotal (C)	46,111	448,202
(6) Training	507	4,929
Subtotal (D)	46,619	453,132
(7) Q&RA	9,324	90,626
(8) Mfg. Tech.	886	10,460
Total Production Labor	56,828	\$554,218
<u>Material</u>		
(9) Raw Material & Standards		\$157,006
(10) Q&RA		2,797
(11) Mfg. Tech.		1,550
Material Subtotal		161,353
(12) Material & Adm. Burden		54,860
Total Material		216,213
Total Production Cost		\$770,431

PART II
MANUFACTURING
TOOLING

THRUST STRUCTURE-EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.5-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,274	\$ 22,103
(2) Direct Distributabel	728	7,072
Subtotal (A)	3,002	29,175
(3) Training	33	321
Subtotal (B)	3,035	29,496
(4) Q&RA	607	5,899
Total Tooling Labor	<u>3,642</u>	<u>\$35,395</u>
Material		
(5) Tooling		\$ 3,980
(6) Q&RA		182
Subtotal (C)		4,162
(7) Material & Adm. Burden		1,415
Total Material		<u>5,577</u>
Total Tooling Cost		<u>\$40,972</u>

PART II
MANUFACTURING
MANUFACTURING TEST
THRUST STRUCTURE-EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.5-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,305	\$12,685
Component Test Planning	418	4,059
(1) Subtotal (A)	1,723	16,744
(2) Direct Distributable	551	5,358
Subtotal (B)	2,274	22,102
(3) Training	25	243
Subtotal (C)	2,299	22,345
(4) Mfg. Tech.	44	515
Subtotal (D)	2,343	22,860
(5) Q&RA	460	4,468
Total Mfg. Test Labor	<u>2,803</u>	<u>\$27,328</u>
Material		
(6) Q&RA		138
(7) Mfg. Tech.		76
Subtotal (E)		214
(8) Material & Adm. Burden		73
Total Material		<u>287</u>
Total Mfg. Test Cost		<u>\$27,615</u>

MLLV
PART III
FACILITY LABOR
THRUST STRUCTURE-EM
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.1.5-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	853	\$8,291
TOTAL FACILITY LABOR COST	<u>853</u>	<u>\$8,291</u>

MLLV
PART IV
LOGISTIC LABOR
THRUST STRUCTURE-EM
ASSEMBLY OR SYSTEM

TABLE 5.2.1.5-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,572</u>	\$ 18,565
(2) Hardware		88,032
(3) Material & Adm. Burden		<u>29,931</u>
Total Material		<u>\$117,963</u>
Total Logistic Cost		<u>\$136,528</u>

5.2.1.6 Structure Assembly - Injection Stage Engine Module

TABLE 5.2.1.6-I

MLLV COST SUMMARY STRUCTURE ASSY. - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	21								2	21
PROGRAM PLAN. & REPT.	4	54								4	54
INDUSTRIAL RELATIONS	1	10								1	10
ENGINEERING			24	279			4	43		28	322
LAB TECHNICIANS			5	46						5	46
TOOLING			5	50						5	50
PRODUCTION			83	808						83	808
MANUFACTURING TEST			4	38						4	38
MANUFACTURING TECH.			2	24						2	24
Q & R A			23	235						23	235
FACILITIES					2	19				2	19
DIRECT DIST			24	226						24	226
TRAINING			1	12						1	12
TOTAL DIRECT LABOR	7	\$85	171	\$1,718	2	\$19	4	\$43		184	\$1,865
MATERIAL				31							31
LOGISTIC HARDWARE								204			204
BURDEN				9				70			79
TOTAL MATERIAL				\$40				\$274			\$314
TOTAL OTHER											
TOTAL COST		\$85		\$1,718		\$19		\$317			\$2,179

006

MLLV
NON-RECURRING
PART I
STRUCTURE ASSY. - EM
ASSEMBLY OR SYSTEM
TABLE 5.2.1.6-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	24		
Logistics	4		
Laboratory Technician	5		
Production	83		
Tooling	5		
Manufacturing Test	4		
Q&RA	23		
Facilities	2		
Manufacturing Technician	<u>2</u>		
Total Direct Labor	<u>152,000</u>		
Program Executive		1,824	\$21,544
Program Planning & Reporting		4,560	53,853
Industrial Relations		<u>988</u>	<u>9,603</u>
Total Labor - Part I		<u>7,372</u>	<u>\$85,000</u>
<u>Material</u>			
Program Planning & Reporting			91
Industrial Relations			<u>98</u>
Material Subtotal			189
Material & Administrative Burden			<u>64</u>
Total Material			<u>253</u>
TOTAL COST - PART I			<u>\$85,253</u>

TABLE 5.2.1.6-III

MLLV PART II COST SUMMARY STRUCTURE ASSY. - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	24	279							24	279
LAB TECHNICIANS	5	46							5	46
TOOLING					5	50			5	50
PRODUCTION			83	808					83	808
MANUFACTURING TEST							4	38	4	38
MANUFACTURING TECH.			2	24			4		2	24
Q & R A	1	9	21	203	1	13	1	10	23	235
DIRECT DIST			20	198	2	16	1	12	23	226
TRAINING			2	11				1	2	12
TOTAL DIRECT LABOR	29	\$334	128	\$1,244	8	\$79	6	\$61	171	\$1,718
MATERIAL										
LAB. TECHNICIANS		10								10
TOOLING						9				9
PRODUCTION										
MFG. TECHNICIANS				4						4
Q & R A				6		1		1		8
SUBTOTAL		10		10		10		1		31
MAT. & ADM. BURDEN		3		3		3				9
TOTAL MATERIAL		\$13		\$ 13		\$13		\$1		\$ 40
TOTAL PART II COST		\$347		\$1,257		\$92		\$62		\$1,758

MLLV
PART II
ENGINEERING

STRUCTURE ASSEMBLY-E/M

ASSEMBLY OR SYSTEM

TABLE 5.2.1.6-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	23,094	\$ 272,740
Reliability Engineering	499	5,893
(1) Subtotal (A)	23,593	278,633
(2) Laboratory Technicians	4,719	45,869
Subtotal (B)	28,312	324,502
(3) Q&RA	944	9,176
Total Engineering Labor	<u>29,256</u>	<u>\$ 333,678</u>
Material		
(4) Lab. Tech.		9,910
(5) Q&RA		283
Subtotal (C)		10,193
(6) Material & Adm. Burden		3,466
Total Material		<u>\$ 13,659</u>
Total Engineering Cost		<u>\$ 347,337</u>

MLLV
PART II.
MANUFACTURING
PRODUCTION

STRUCTURE ASSY. -E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.6-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	58,564	569,242
(2) Miscellaneous Charges	4,568	44,401
(3) Maintain & Add in Scope Changes	644	6,260
Subtotal (A)	63,776	619,903
(4) Tool & Production Planning	19,285	187,458
Subtotal (B)	83,061	807,361
(5) Direct Distributable	20,409	198,369
Subtotal (C)	103,470	1,005,730
(6) Training	1,138	11,062
Subtotal (D)	104,608	1,016,792
(7) Q&RA	20,922	203,358
(8) Mfg. Tech.	1,987	23,472
Total Production Labor	<u>127,517</u>	<u>1,243,622</u>
Material		
(9) Raw Material & Standards		-0-
(10) Q&RA		6,277
(11) Mfg. Tech.		3,478
Material Subtotal		9,755
(12) Material & Adm. Burden		3,316
Total Material		<u>13,071</u>
Total Production Cost		<u>1,256,693</u>

MLLV
PART II
MANUFACTURING
TOOLING

STRUCTURE ASSY.-EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.6-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	5,102	49,592
(2) Direct Distributabel	1,632	15,868
Subtotal (A)	6,734	65,460
(3) Training	74	719
Subtotal (B)	6,808	66,179
(4) Q&RA	1,361	13,236
Total Tooling Labor	8,169	79,415
Material		
(5) Tooling		8,928
(6) Q&RA		408
Subtotal (C)		9,336
(7) Material & Adm. Burden		3,175
Total Material		12,511
Total Tooling Cost		91,926

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

STRUCTURE ASSY. - EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.6-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	2,928	28,460
Component Test Planning	936	9,107
(1) Subtotal (A)	3,864	37,566
(2) Direct Distributable	1,235	12,020
Subtotal (B)	5,101	49,587
(3) Training	56	545
Subtotal (C)	5,157	50,132
(4) Mfg. Tech.	98	1,156
Subtotal (D)	5,255	51,288
(5) Q&RA	1,032	10,026
Total Mfg. Test Labor	6,287	61,315
Material		
(6) Q&RA		309
(7) Mfg. Tech.		171
Subtotal (E)		480
(8) Material & Adm. Burden		163
Total Material		644
Total Mfg. Test Cost		\$61,959

MLLV
PART III
FACILITY LABOR

STRUCTURES ASSEMBLY -EM

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.1.6-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,913	\$18,594
TOTAL FACILITY LABOR COST	<u>1,913</u>	<u>\$18,594</u>

MLLV
PART IV
LOGISTIC LABOR
STRUCTURE ASSEMBLY
ASSEMBLY OR SYSTEM
TABLE 5.2.1.6-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	3,652	\$ 43,130
(2) Hardware		204,512
(3) Material & Adm. Burden		69,534
Total Material		<u>\$ 274,046</u>
Total Logistic Cost		<u>\$ 317,176</u>

5.2.2 Systems - Injection Stage Engine Module

The total first production unit cost of the systems for an engine module and the components thereof are displayed in Figure 5.2.2.0-1. Table 5.2.2.0-I is a total cost summary of the systems. Supporting documentation for each of the major components that are included in this cost summary are in the appropriate sections.

TABLE 5.2.2.0-I

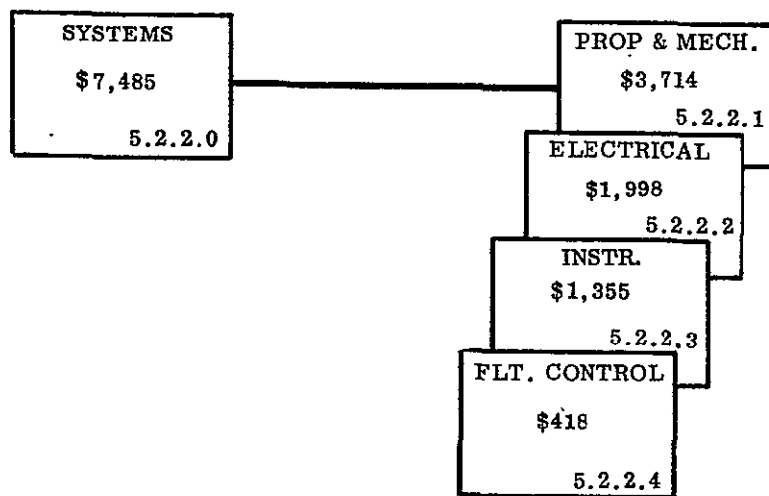
MLLV COST SUMMARY

TOTAL SYSTEMS - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	61								5	61
PROGRAM PLAN. & REPT.	13	153								13	153
INDUSTRIAL RELATIONS	2	27								2	27
ENGINEERING			58	678			8	103		66	781
LAB TECHNICIANS			12	111						12	111
TOOLING			15	146						15	146
PRODUCTION			244	2,373						244	2,373
MANUFACTURING TEST			13	110						13	110
MANUFACTURING TECH.			5	72						5	72
Q & R A			70	689						70	689
FACILITIES					5	56				5	56
DIRECT DIST			69	665						69	665
TRAINING			3	37						3	37
TOTAL DIRECT LABOR	20	241	489	4,881	5	56	8	103		522	5,281
MATERIAL				1,161							1,161
LOGISTIC HARDWARE								485			485
BURDEN				394				164			558
TOTAL MATERIAL				1,555				649			2,204
TOTAL OTHER											
TOTAL COST		241		6,436		56		752			7,485



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 5.2.2.0-1 ENGINE MODULE SYSTEMS COST FLOW DIAGRAM

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5.2.2.1 Propulsion/Mechanical System - Injection Stage Engine Module

TABLE 5.2.2.1-I

MLLV COST SUMMARY

PROPULSION & MECHANICAL - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	25								2	25
PROGRAM PLAN. & REPT.	5	61								5	61
INDUSTRIAL RELATIONS	1	11								1	11
ENGINEERING			23	267			3	40		26	307
LAB TECHNICIANS			5	44						5	44
TOOLING			6	59						6	59
PRODUCTION			98	955						98	955
MANUFACTURING TEST			5	44						5	44
MANUFACTURING TECH.			2	29						2	29
Q & R A			28	277						28	277
FACILITIES					2	22				2	22
DIRECT DIST			28	268						28	268
TRAINING			1	15						1	15
TOTAL DIRECT LABOR	8	97	196	1,958	2	22	3	40		209	2,117
MATERIAL				1,001							1,001
LOGISTIC HARDWARE								191			191
BURDEN				340				65			405
TOTAL MATERIAL				1,341				256			1,597
TOTAL OTHER											
TOTAL COST		97		3,299		22		296			3,714

MLLV
 RECURRING
 PART I
 PROPULSION & MECHANICAL - E/M
 ASSEMBLY OR SYSTEM
 TABLE 5.2.2.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	22,594		
Logistics	3,406		
Laboratory Technician	4,519		
Production	98,262		
Tooling	6,036		
Manufacturing Test	4,572		
Q&RA	28,485		
Facilities	2,263		
Manufacturing Technician	2,467		
Total Direct Labor	<u>172,604</u>		
Program Executive		2,071	24,461
Program Planning & Reporting		5,178	61,153
Industrial Relations		<u>1,122</u>	<u>10,905</u>
Total Labor - Part I		<u>8,371</u>	<u>96,519</u>
<u>Material</u>			
Program Planning & Reporting			104
Industrial Relations			112
Material Subtotal			216
Material & Administrative Burden			<u>73</u>
Total Material			<u>289</u>
TOTAL COST - PART I			<u>96,808</u>

TABLE 5.2.2.1.-III

MLLV PART II COST SUMMARY PROPULSION & MECHANICAL - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	23	267							23	267
LAB TECHNICIANS	4	44							4	44
TOOLING					6	59			6	59
PRODUCTION			98	955					98	955
MANUFACTURING TEST							5	44	5	44
MANUFACTURING TECH.			2	27				1	2	28
Q & R A	1	9	25	241	2	15	1	12	29	277
DIRECT DIST			24	235	2	19	1	14	27	268
TRAINING			1	13		1		1	1	15
TOTAL DIRECT LABOR	28	320	150	1,471	10	94	7	72	195	1,957
MATERIAL										
LAB. TECHNICIANS		10								10
TOOLING						11				11
PRODUCTION				969						969
MFG. TECHNICIANS				4						4
Q & R A				7				1		8
SUBTOTAL		10		980		11		1		1,002
MAT. & ADM. BURDEN		3		333		4				340
TOTAL MATERIAL		13		1,313		15		1		1,342
TOTAL PART II COST		333		2,784		109		73		3,299

MLLV
PART IIA
ENGINEERING

PROPULSION & MECHANICAL SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	22,126	\$ 261,308
Reliability Engineering	<u>468</u>	<u>5,527</u>
(1) Subtotal (A)	22,594	266,835
(2) Laboratory Technicians	<u>4,519</u>	<u>43,924</u>
Subtotal (B)	<u>27,113</u>	<u>310,759</u>
(3) Q&RA	904	8,787
Total Engineering Labor	<u>28,017</u>	<u>\$ 319,546</u>
Material		
(4) Lab. Tech.		\$ 9,490
(5) Q&RA		<u>271</u>
Subtotal (C)		9,761
(6) Material & Adm. Burden		<u>3,319</u>
Total Material		<u>\$ 13,080</u>
Total Engineering Cost		<u><u>\$332,626</u></u>

MLJW
PART II
MANUFACTURING
PRODUCTION

PROP. & MECH. SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>69,281</u>	\$ <u>673,411</u>
(2) Miscellaneous Charges	<u>5,404</u>	<u>52,526</u>
(3) Maintain & Add in Scope Changes	<u>762</u>	<u>7,407</u>
Subtotal	75,447	733,344
(4) Tool & Production Planning	<u>22,815</u>	<u>221,763</u>
Subtotal	98,262	955,107
(5) Direct Distributable	<u>24,143</u>	<u>234,670</u>
Subtotal	122,405	1,189,776
(6) Training	<u>1,346</u>	<u>13,087</u>
Subtotal	123,751	1,202,863
(7) Q&RA	<u>24,750</u>	<u>240,572</u>
(8) Mfg. Tech.	<u>2,351</u>	<u>27,768</u>
Total Production Labor	<u>150,853</u>	<u>\$1,471,203</u>
Material		
(9) Raw Material & Standards		\$ <u>968,466</u>
(10) Q&RA		<u>7,425</u>
(11) Mfg. Tech.		<u>4,115</u>
Material Subtotal		980,006
(12) Material & Adm. Burden		<u>333,202</u>
Total Material		<u>1,313,208</u>
Total Production Cost		<u>\$2,784,411</u>

MLLV
PART II
MANUFACTURING
TOOLING

PROPULSION & MECHANICAL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>6,036</u>	\$ <u>58,670</u>
(2) Direct Distributable	<u>1,932</u>	<u>18,774</u>
Subtotal	<u>7,968</u>	<u>77,444</u>
(3) Training	<u>88</u>	<u>851</u>
Subtotal	<u>8,055</u>	<u>78,295</u>
(4) Q&RA	<u>1,611</u>	<u>15,659</u>
Total Tooling Labor	<u><u>9,666</u></u>	\$ <u><u>93,954</u></u>
Material		
(5) Tooling		\$ <u>10,563</u>
(6) Q&RA		<u>483</u>
Subtotal		<u>11,046</u>
(7) Material & Adm. Burden		<u>3,756</u>
Total Material		<u><u>14,802</u></u>
Total Tooling Cost		\$ <u><u>108,756</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
PROP. & MECH. SYSTEM - E/M

TABLE 5.2.2.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	3,464	33,670
Component Test Planning	<u>1,108</u>	<u>10,774</u>
Subtotal	4,572	44,444
Direct Distributable	<u>1,463</u>	<u>14,221</u>
Subtotal	6,035	58,665
Training	<u>66</u>	<u>644</u>
Subtotal	6,101	59,309
Mfg. Tech.	<u>116</u>	<u>1,369</u>
Subtotal	6,217	60,678
Q&RA	<u>1,220</u>	<u>11,861</u>
Total Mfg. Test Labor	<u><u>7,437</u></u>	<u><u>72,539</u></u>
Material		
Q&RA		366
Mfg. Tech.		<u>203</u>
Subtotal		569
Material & Adm. Burden		<u>193</u>
Total Material		<u><u>762</u></u>
Total Mfg. Test Cost		<u><u>73,301</u></u>

MLLV
PART III
FACILITY LABOR

PROPULSION AND MECHANICAL SYSTEM - E/M

ASSEMBLY OR SYSTEM

1ST UNIT COST

TABLE 5.2.2.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	2,263	\$21,996
TOTAL FACILITY LABOR COST	<u>2,263</u>	<u>\$21,996</u>

MLLV
PART IV
LOGISTIC LABOR

PROPULSION & MECHANICAL SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>3,406</u>	<u>\$ 40,225</u>
(2) Hardware		<u>190,736</u>
(3) Material & Adm. Burden		<u>64,850</u>
Total Material		<u>\$ 255,586</u>
Total Logistic Cost		<u>\$ 295,811</u>

5.2.2.2 Electrical System - Injection Stage Engine Module

ELECTRICAL - ENGINE MODULE

TABLE 5.2.2.2-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	21								2	21
PROGRAM PLAN. & REPT.	4	53								4	53
INDUSTRIAL RELATIONS	1	10								1	10
ENGINEERING			9	103			1	16		10	119
LAB TECHNICIANS			2	17						2	17
TOOLING			6	57						6	57
PRODUCTION			96	931						96	931
MANUFACTURING TEST			5	43						5	43
MANUFACTURING TECH.			2	29						2	29
Q & R A			27	265						27	265
FACILITIES					2	22				2	22
DIRECT DIST			27	261						27	261
TRAINING			1	14						1	14
TOTAL DIRECT LABOR	7	84	175	1,720	2	22	1	16		185	1,842
MATERIAL				43							43
LOGISTIC HARDWARE								73			73
BURDEN				15				25			40
TOTAL MATERIAL				58				98			156
TOTAL OTHER											
TOTAL COST		84		1,778		22		114			1,998

MLLV
 RECURRING
 PART I
 ELECTRICAL - E/M
ASSEMBLY OR SYSTEM
 TABLE 5.2.2.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	8,690		
Logistics	1,310		
Laboratory Technician	1,738		
Production	95,820		
Tooling	5,886		
Manufacturing Test	4,459		
Q&RA	27,244		
Facilities	2,207		
Manufacturing Technician	<u>2,406</u>		
Total Direct Labor	<u>149,760</u>		
Program Executive		1,797	21,224
Program Planning & Reporting		4,493	53,060
Industrial Relations		<u>973</u>	<u>9,461</u>
Total Labor - Part I		<u>7,263</u>	<u>83,745</u>
<u>Material</u>			
Program Planning & Reporting			90
Industrial Relations			97
Material Subtotal			<u>187</u>
Material & Administrative Burden			<u>64</u>
Total Material			<u>251</u>
TOTAL COST - PART I			<u>83,996</u>

TABLE 5.2.2.2-III

MLLV PART II COST SUMMARY

ELECTRICAL - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	9	103							9	103
LAB TECHNICIANS	2	17							2	17
TOOLING					6	57			6	57
PRODUCTION			96	931					96	931
MANUFACTURING TEST							4	44	4	44
MANUFACTURING TECH.			2	27				1	2	28
Q & R A		3	24	235	2	15	1	12	27	265
DIRECT DIST			24	229	2	18	1	14	27	261
TRAINING			1	13		1			1	14
TOTAL DIRECT LABOR	11	123	147	1,435	10	91	7	71	174	1,720
MATERIAL										
LAB. TECHNICIANS		4								4
TOOLING						10				10
PRODUCTION				17						17
MFG. TECHNICIANS				4						4
Q & R A				7				1		8
SUBTOTAL		4		28		10		1		43
MAT. & ADM. BURDEN		1		10		4				15
TOTAL MATERIAL		5		38		14		1		58
TOTAL PART II COST		128		1,473		105		72		1,778

MLLV
PART II-
ENGINEERING
ELECTRICAL SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	8,510	\$ 100,503
Reliability Engineering	<u>180</u>	<u>2,126</u>
(1) Subtotal (A)	8,690	102,629
(2) Laboratory Technicians	<u>1,738</u>	<u>16,893</u>
Subtotal (B)	10,428	119,522
(3) Q&RA	<u>348</u>	<u>3,383</u>
Total Engineering Labor	<u>10,776</u>	<u>\$ 122,905</u>
Material		
(4) Lab. Tech.		\$ 3,650
(5) Q&RA		<u>104</u>
Subtotal (C)		3,754
(6) Material & Adm. Burden		<u>1,276</u>
Total Material		<u>\$ 5,030</u>
Total Engineering Cost		<u><u>\$127,935</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION

ELECTRICAL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>67,559</u>	\$ <u>656,673</u>
(2) Miscellaneous Charges	<u>5,270</u>	<u>51,221</u>
(3) Maintain & Add in Scope Changes	<u>743</u>	<u>7,223</u>
Subtotal	73,572	715,117
(4) Tool & Production Planning	<u>22,248</u>	<u>216,251</u>
Subtotal	95,820	931,368
(5) Direct Distributable	<u>23,543</u>	<u>228,837</u>
Subtotal	119,363	1,160,205
(6) Training	<u>1,313</u>	<u>12,761</u>
Subtotal	120,676	1,172,966
(7) Q&RA	<u>24,135</u>	<u>234,593</u>
(8) Mfg. Tech.	<u>2,293</u>	<u>27,078</u>
Total Production Labor	<u>147,103</u>	<u>\$1,434,637</u>
Material		
(9) Raw Material & Standards		\$ <u>17,227</u>
(10) Q&RA		<u>7,241</u>
(11) Mfg. Tech.		<u>4,012</u>
Material Subtotal		28,480
(12) Material & Adm. Burden		<u>9,683</u>
Total Material		<u>38,163</u>
Total Production Cost		<u>\$1,472,800</u>

MILV
PART II
MANUFACTURING
TOOLING

ELECTRICAL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>5,886</u>	\$ <u>57,212</u>
(2) Direct Distributable	<u>1,884</u>	<u>18,308</u>
Subtotal	<u>7,770</u>	<u>75,520</u>
(3) Training	<u>85</u>	<u>830</u>
Subtotal	<u>7,855</u>	<u>76,350</u>
(4) Q&RA	<u>1,571</u>	<u>15,269</u>
Total Tooling Labor	<u><u>9,426</u></u>	\$ <u><u>91,619</u></u>
Material		
(5) Tooling		\$ <u>10,301</u>
(6) Q&RA		<u>471</u>
Subtotal		<u>10,772</u>
(7) Material & Adm. Burden		<u>3,662</u>
Total Material		<u><u>14,434</u></u>
Total Tooling Cost		\$ <u><u>106,053</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
ELECTRICAL SYSTEM - E/M

TABLE 5.2.2.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	3,378	32,834
Component Test Planning	<u>1,081</u>	<u>10,506</u>
Subtotal	4,459	43,340
Direct Distributable	<u>1,427</u>	<u>13,868</u>
Subtotal	5,886	57,208
Training	<u>65</u>	<u>629</u>
Subtotal	5,951	57,837
Mfg. Tech.	<u>113</u>	<u>1,335</u>
Subtotal	6,064	59,172
Q&RA	<u>1,190</u>	<u>11,567</u>
Total Mfg. Test Labor	<u>7,254</u>	<u>70,739</u>
Material		
Q&RA		357
Mfg. Tech.		<u>198</u>
Subtotal		555
Material & Adm. Burden		<u>186</u>
Total Material		<u>741</u>
Total Mfg. Test Cost		<u>71,480</u>

MLLV
PART III
FACILITY LABOR

ELECTRICAL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.2-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	2,207	\$21,452
TOTAL FACILITY LABOR COST	<u>2,207</u>	<u>\$21,452</u>

MLLV
PART IV
LOGISTIC LABOR
ELECTRICAL SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>1,310</u>	<u>\$ 15,471</u>
(2) Hardware		<u>73,360</u>
(3) Material & Adm. Burden		<u>24,942</u>
Total Material		<u>\$ 98,302</u>
Total Logistic Cost		<u>\$113,773</u>

5.2.2.3 Instrumentation System - Injection Stage Engine Module

TABLE 5.2.2.3-I

MLLV COST SUMMARY INSTRUMENTATION - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	12								1	12
PROGRAM PLAN. & REPT.	3	31								3	31
INDUSTRIAL RELATIONS		5									5
ENGINEERING			22	257			3	39		25	296
LAB TECHNICIANS			4	42						4	42
TOOLING			2	23						2	23
PRODUCTION			39	379						39	379
MANUFACTURING TEST			2	18						2	18
MANUFACTURING TECH.			1	11						1	11
Q & R A			12	115						12	115
FACILITIES					1	9				1	9
DIRECT DIST			11	106						11	106
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	4	48	94	957	1	9	3	39		102	1,053
MATERIAL				42							42
LOGISTIC HARDWARE								184			184
BURDEN				14				62			76
TOTAL MATERIAL				56				246			302
TOTAL OTHER											
TOTAL COST		48		1,013		9		285			1,355

MLLV
RECURRING
PART I
INSTRUMENTATION - E/M
ASSEMBLY OR SYSTEM

TABLE 5.2.2.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	21,725		
Logistics	3,275		
Laboratory Technician	4,345		
Production	38,967		
Tooling	2,394		
Manufacturing Test	1,814		
Q&RA	11,807		
Facilities	898		
Manufacturing Technician	978		
Total Direct Labor	<u>86,203</u>		
Program Executive		1,034	12,216
Program Planning & Reporting		2,586	30,541
Industrial Relations		<u>560</u>	<u>5,446</u>
Total Labor - Part I		<u>4,180</u>	<u>48,203</u>
<u>Material</u>			
Program Planning & Reporting			52
Industrial Relations			56
Material Subtotal			108
Material & Administrative Burden			<u>37</u>
Total Material			<u>145</u>
TOTAL COST - PART I			<u>48,348</u>

TABLE 5.2.2.3-III

MLLV PART II COST SUMMARY INSTRUMENTATION - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	22	257							22	257
LAB TECHNICIANS	4	42							4	42
TOOLING					2	23			2	23
PRODUCTION			39	379					39	379
MANUFACTURING TEST							2	18	2	18
MANUFACTURING TECH.			1	11					1	11
Q & R A	1	8	10	95	1	7		5	12	115
DIRECT DIST			10	93	1	7	1	6	12	106
TRAINING				5						5
TOTAL DIRECT LABOR	27	307	60	583	4	37	3	29	94	956
MATERIAL										
LAB. TECHNICIANS		9								9
TOOLING						4				4
PRODUCTION				24						24
MFG. TECHNICIANS				2						2
Q & R A		1		3		1				5
SUBTOTAL		10		29		5				44
MAT. & ADM. BURDEN		3		9		1				13
TOTAL MATERIAL		13		38		6				57
TOTAL PART II COST		320		621		43		29		1,013

MLLV
PART II
ENGINEERING
INSTRUMENTATION SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	21,275	\$ 251,258
Reliability Engineering	<u>450</u>	<u>5,314</u>
(1) Subtotal (A)	21,725	256,572
(2) Laboratory Technicians	<u>4,345</u>	<u>42,233</u>
Subtotal (B)	26,070	298,805
(3) Q&RA	<u>869</u>	<u>8,447</u>
Total Engineering Labor	<u>26,939</u>	<u>\$ 307,252</u>
Material		
(4) Lab. Tech.		\$ 9,125
(5) Q&RA		<u>261</u>
Subtotal (C)		9,386
(6) Material & Adm. Burden		<u>3,191</u>
Total Material		<u>\$ 12,577</u>
Total Engineering Cost		<u>\$319,829</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

INSTRUMENTATION SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>27,474</u>	\$ <u>267,047</u>
(2) Miscellaneous Charges	<u>2,143</u>	<u>26,829</u>
(3) Maintain & Add in Scope Changes	<u>302</u>	<u>2,937</u>
Subtotal	29,919	290,813
(4) Tool & Production Planning	<u>9,048</u>	<u>87,942</u>
Subtotal	38,967	378,755
(5) Direct Distributable	<u>9,574</u>	<u>93,060</u>
Subtotal	48,541	471,815
(6) Training	<u>534</u>	<u>5,190</u>
Subtotal	49,075	477,005
(7) Q&RA	<u>9,815</u>	<u>95,401</u>
(8) Mfg. Tech.	<u>932</u>	<u>11,012</u>
Total Production Labor	<u>59,822</u>	<u>583,417</u>
Material		
(9) Raw Material & Standards		\$ <u>23,753</u>
(10) Q&RA		<u>2,944</u>
(11) Mfg. Tech.		<u>1,632</u>
Material Subtotal		28,329
(12) Material & Adm. Burden		<u>9,632</u>
Total Material		<u>37,961</u>
Total Production Cost		\$ <u>621,378</u>

MLLV
PART II
MANUFACTURING
TOOLING

INSTRUMENTATION SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,394	\$ 23,270
(2) Direct Distributable	766	7,445
Subtotal	3,160	30,715
(3) Training	35	337
Subtotal	3,195	31,052
(4) Q&RA	639	6,210
Total Tooling Labor	<u>3,834</u>	<u>\$ 37,262</u>
Material		
(5) Tooling		\$ 4,190
(6) Q&RA		192
Subtotal		4,382
(7) Material & Adm. Burden		1,490
Total Material		<u>5,872</u>
Total Tooling Cost		<u>\$ 43,134</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
INSTRUMENTATION SYSTEM - E/M

TABLE 5.2.2.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,374	13,355
Component Test Planning	<u>440</u>	<u>4,273</u>
Subtotal	1,814	17,628
Direct Distributable	<u>580</u>	<u>5,641</u>
Subtotal	2,394	23,269
Training	<u>26</u>	<u>256</u>
Subtotal	2,420	23,524
Mfg. Tech.	<u>46</u>	<u>542</u>
Subtotal	2,466	24,066
Q&RA	<u>484</u>	<u>4,704</u>
Total Mfg. Test Labor	<u>2,950</u>	<u>28,770</u>
Material		
Q&RA		145
Mfg. Tech.		<u>80</u>
Subtotal		225
Material & Adm. Burden		<u>77</u>
Total Material		<u>302</u>
Total Mfg. Test Cost		<u>29,072</u>

MLLV
PART III
FACILITY LABOR

INSTRUMENTATION SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	898	\$8,729
TOTAL FACILITY LABOR COST	<u>898</u>	<u>\$8,729</u>

MLLV
PART IV
LOGISTIC LABOR

INSTRUMENTATION SYSTEM - E/M
ASSEMBLY OR SYSTEM

TABLE 5.2.2.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>3,275</u>	<u>\$ 38,678</u>
(2) Hardware		<u>183,400</u>
(3) Material & Adm. Burden		<u>62,356</u>
Total Material		<u>\$ 245,756</u>
Total Logistic Cost		<u>\$ 284,434</u>

5.2.2.4 Flight Control - Injection Stage Engine Module

TABLE 5.2.2.4-I

MLLV COST SUMMARY

FLIGHT CONTROL - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		3									3
PROGRAM PLAN. & REPT.	1	8								1	8
INDUSTRIAL RELATIONS		1									1
ENGINEERING			4	51			1	8		5	59
LAB TECHNICIANS			1	8						1	8
TOOLING			1	7						1	7
PRODUCTION			11	108						11	108
MANUFACTURING TEST			1	5						1	5
MANUFACTURING TECH.				3							3
Q & R A			3	32						3	32
FACILITIES						3					3
DIRECT DIST			3	30						3	30
TRAINING				2							2
TOTAL DIRECT LABOR	1	12	24	246		3	1	8		26	269
MATERIAL				75							75
LOGISTIC HARDWARE								37			37
BURDEN				25				12			37
TOTAL MATERIAL				100				49			149
TOTAL OTHER											
TOTAL COST		12		346		3		57			418

MLLV
 RECURRING
 PART I
 FLIGHT CONTROL - E/M
ASSEMBLY OR SYSTEM
 TABLE 5.2.2.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	4,345		
Logistics	.655		
Laboratory Technician	869		
Production	11,066		
Tooling	680		
Manufacturing Test	515		
Q&RA	3,279		
Facilities	255		
Manufacturing Technician	278		
Total Direct Labor	21,942		
Program Executive		263	3,110
Program Planning & Reporting		658	7,773
Industrial Relations		143	1,386
Total Labor - Part I		1,064	12,269
<u>Material</u>			
Program Planning & Reporting			13
Industrial Relations			14
Material Subtotal			27
Material & Administrative Burden			9
Total Material			36
TOTAL COST - PART I			12,305

TABLE 5.2.2.4-III

MLLV PART II COST SUMMARY FLIGHT CONTROL - E/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	4	51							4	51
LAB TECHNICIANS	1	9							1	9
TOOLING					1	7			1	7
PRODUCTION			11	108					11	108
MANUFACTURING TEST							1	5	1	5
MANUFACTURING TECH.				4		2				2
Q & R A		1	3	27				1	3	29
DIRECT DIST			3	26		2		2	3	30
TRAINING				1						1
TOTAL DIRECT LABOR	5	61	17	166	1	11	1	8	24	246
MATERIAL										
LAB. TECHNICIANS		2								2
TOOLING						1				1
PRODUCTION				70						70
MFG. TECHNICIANS										
Q & R A				1						1
SUBTOTAL		2		71		1				74
MAT. & ADM. BURDEN		1		24		1				26
TOTAL MATERIAL		3		95		2				100
TOTAL PART II COST		64		261		13		8		346

MLLV
PART II
ENGINEERING

FLIGHT CONTROL SYSTEM - E/M

ASSEMBLY OR SYSTEM

TABLE 5.2.2.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	4,255	\$ 50,252
Reliability Engineering	<u>90</u>	<u>1,062</u>
(1) Subtotal (A)	4,345	51,314
(2) Laboratory Technicians	<u>869</u>	<u>8,447</u>
Subtotal (B)	5,214	59,761
(3) Q&RA	<u>174</u>	<u>1,691</u>
Total Engineering Labor	<u>5,388</u>	<u>\$ 61,452</u>
Material		
(4) Lab. Tech.		\$ 1,825
(5) Q&RA		<u>52</u>
Subtotal (C)		1,877
(6) Material & Adm. Burden		<u>638</u>
Total Material		<u>\$ 2,515</u>
Total Engineering Cost		<u>\$ 63,967</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

FLIGHT CONTROL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>7,802</u>	\$ <u>75,835</u>
(2) Miscellaneous Charges	<u>609</u>	<u>5,915</u>
(3) Maintain & Add in Scope Changes	<u>86</u>	<u>834</u>
Subtotal	8,496	82,584
(4) Tool & Production Planning	<u>2,569</u>	<u>24,973</u>
Subtotal	11,066	107,557
(5) Direct Distributable	<u>2,719</u>	<u>26,427</u>
Subtotal	13,784	133,983
(6) Training	<u>152</u>	<u>1,474</u>
Subtotal	13,936	135,457
(7) Q&RA	<u>2,787</u>	<u>27,091</u>
(8) Mfg. Tech.	<u>265</u>	<u>3,126</u>
Total Production Labor	<u>16,988</u>	\$ <u>165,673</u>
Material		
(9) Raw Material & Standards		\$ <u>70,178</u>
(10) Q&RA		<u>836</u>
(11) Mfg. Tech.		<u>463</u>
Material Subtotal		71,477
(12) Material & Adm. Burden		<u>24,302</u>
Total Material		<u>95,780</u>
Total Production Cost		\$ <u>261,453</u>

MLLV
PART II
MANUFACTURING
TOOLING

FLIGHT CONTROL SYSTEM - E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>680</u>	\$ <u>6,610</u>
(2) Direct Distributable	<u>218</u>	<u>2,115</u>
Subtotal	898	8,725
(3) Training	<u>10</u>	<u>95</u>
Subtotal	907	8,820
(4) Q&RA	<u>181</u>	<u>1,763</u>
Total Tooling Labor	<u><u>1,088</u></u>	\$ <u><u>10,583</u></u>
Material		
(5) Tooling		\$ <u>1,190</u>
(6) Q&RA		<u>54</u>
Subtotal		1,244
(7) Material & Adm. Burden		<u>423</u>
Total Material		<u><u>1,667</u></u>
Total Tooling Cost		\$ <u><u>12,250</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST- E/M
FLIGHT CONTROL SYSTEM
TABLE 5.2.2.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	390	3,791
Component Test Planning	<u>125</u>	<u>1,213</u>
Subtotal	515	5,004
Direct Distributable	<u>165</u>	<u>1,601</u>
Subtotal	680	6,605
Training	<u>7</u>	<u>72</u>
Subtotal	687	6,677
Mfg. Tech.	<u>13</u>	<u>154</u>
Subtotal	700	6,831
Q&RA	<u>137</u>	<u>1,335</u>
Total Mfg. Test Labor	<u>837</u>	<u>8,166</u>
Material		
Q&RA		<u>41</u>
Mfg. Tech.		<u>23</u>
Subtotal		64
Material & Adm. Burden		<u>22</u>
Total Material		<u>86</u>
Total Mfg. Test Cost		<u>8,252</u>

MLLV
PART III
FACILITY LABOR

FLIGHT CONTROL SYSTEM - E/M
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.2.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	255	\$2,479
TOTAL FACILITY LABOR COST	<u>255</u>	<u>\$2,479</u>

MLLV
PART IV
LOGISTIC LABOR

FLIGHT CONTROL SYSTEM - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.2.4-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>655</u>	<u>\$ 7,736</u>
(2) Hardware		<u>36,680</u>
(3) Material & Adm. Burden		<u>12,471</u>
Total Material		<u>\$ 49,151</u>
Total Logistic Cost		<u>\$ 56,887</u>

5.2.3 Injection Stage Liquid Engines

Costs for the 125,000 pound (vacuum) thrust high pressure engines were developed from the parametric cost data supplied by Pratt and Whitney.

TABLE 5.2.3.0-1 MULT-CHAMBER PLUG ENGINE
MLIV COST SUMMARY ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				100							100
LAB TECHNICIANS											
TOOLING				200							200
PRODUCTION				2,200							2,200
MANUFACTURING TEST				200							200
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR				2,700							2,700
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST				2,700							2,700

MLLV
ONE MODULE INJECTION STAGE
*MULTI-CHAMBER
PLUG ENGINE

TABLE 5.2.3.0-II

1ST UNIT

$\$1.05\bar{m}$ avg. X 100 = $\$105\bar{m}$

100th Unit (Cum.) 95% Curve = 76.5863

$\$105\bar{m} \div 76.5863 = \$1.37\bar{m} = \$2.67\bar{m}$

"C" COSTS

Engineering	$\$.10\bar{m}$
Test	$.20\bar{m}$
Tooling (Maint.)	$.20\bar{m}$
Fabrication	<u>$2.20\bar{m}$</u>
Subtotal	$\$2.70\bar{m}$ (Rounded to $\$2.7\bar{m}$)

* 125,000 Thrust

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5.2.4 Engine Installation - Injection Stage Engine Module

Installation costs associated with two engines were based on manhour estimates which were derived from Saturn V historical data. In addition to the direct factory labor, all supporting costs were included.

TABLE 5.2.4.0-I ENGINE INSTALLATION
MLLV COST SUMMARY ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		1									1
PROGRAM PLAN.& REPT.		2									2
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING				2							2
PRODUCTION			4	37						4	37
MANUFACTURING TEST			1	1						1	1
MANUFACTURING TECH.				1							1
Q & R A			1	11						1	11
FACILITIES						1					1
DIRECT DIST			1	10						1	10
TRAINING				1							1
TOTAL DIRECT LABOR		\$3	7	\$63		\$1				7	\$67
MATERIAL				1							1
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				\$ 1							\$ 1
TOTAL OTHER											
TOTAL COST		\$3		\$64		\$1					\$68

MLLV
NON-RECURRING
PART I
ENGINE INSTALLATION - E/M
ASSEMBLY OR SYSTEM

TABLE 5.2.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	3,838		
Tooling	236		
Manufacturing Test	132		
Q&RA	1,065		
Facilities	88		
Manufacturing Technician	<u>95</u>		
Total Direct Labor	<u>5,454</u>		
Program Executive		65	772
Program Planning & Reporting		164	1,932
Industrial Relations		<u>35</u>	<u>344</u>
Total Labor - Part I		<u>264</u>	<u>3,048</u>
<u>Material</u>			
Program Planning & Reporting			3
Industrial Relations			<u>4</u>
Material Subtotal			<u>7</u>
Material & Administrative Burden			<u>2</u>
Total Material			<u>9</u>
TOTAL COST - PART I			<u>3,057</u>

TABLE 5.2.4.0-III

MLLV PART II COST SUMMARY ENGINE INSTALLATION - EM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING						2		1		3
PRODUCTION			4	37					4	37
MANUFACTURING TEST										
MANUFACTURING TECH.				1						1
Q & R A			1	9		1			1	11
DIRECT DIST			1	9		1		1	1	11
TRAINING				1						
TOTAL DIRECT LABOR			6	57		4		2	6	63
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				1						1
SUBTOTAL				1						1
MAT. & ADM. BURDEN										
TOTAL MATERIAL				1						1
TOTAL PART II COST				58		4		2		64

. MLLV
PART II
MANUFACTURING
PRODUCTION

ENGINE INSTALLATION-E/M

ASSEMBLY OR SYSTEM

1ST UNIT COST

TABLE 5.2.4.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	<u>2,706</u>	\$ <u>26,302</u>
(2) Miscellaneous Charges	<u>211</u>	<u>2,051</u>
(3) Maintain & Add in Scope Changes	<u>30</u>	<u>292</u>
Subtotal (A)	<u>2,947</u>	<u>28,645</u>
(4) Tool & Production Planning	<u>891</u>	<u>8,660</u>
Subtotal (B)	<u>3,838</u>	<u>37,305</u>
(5) Direct Distributable	<u>943</u>	<u>9,166</u>
Subtotal (C)	<u>4,781</u>	<u>46,471</u>
(6) Training	<u>53</u>	<u>515</u>
Subtotal (D)	<u>4,834</u>	<u>46,986</u>
(7) Q&RA	<u>967</u>	<u>9,399</u>
(8) Mfg. Tech.	<u>92</u>	<u>1,087</u>
Total Production Labor	<u>5,893</u>	\$ <u>57,472</u>
Material		
(9) Raw Material & Standards		\$ <u>290</u>
(10) Q&RA		<u>161</u>
(11) Mfg. Tech.		<u>451</u>
Material Subtotal		<u>153</u>
(12) Material & Adm. Burden		<u>604</u>
Total Material		<u>58,076</u>
Total Production Cost		\$ <u>58,076</u>

MLLV
PART II
MANUFACTURING
TOOLING

ENGINE INSTALLATION -E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.4.0-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	236	\$ 2,294
(2) Direct Distributable	<u>76</u>	<u>739</u>
Subtotal (A)	312	3,033
(3) Training	<u>3</u>	<u>29</u>
Subtotal (B)	315	3,062
(4) Q&RA	<u>63</u>	<u>612</u>
Total Tooling Labor	<u>378</u>	<u>\$ 3,674</u>
Material		
(5) Tooling		\$ 413
(6) Q&RA		<u>19</u>
Subtotal (C)		<u>432</u>
(7) Material & Adm. Burden		147
Total Material		<u>579</u>
Total Tooling Cost		<u>\$ 4,253</u>

PART II
MANUFACTURING
MANUFACTURING TEST
ENGINE INSTALLATION-E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.2.4.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	100	972
Component Test Planning	<u>32</u>	<u>311</u>
(1) Subtotal	132	1,283
(2) Direct Distributable	<u>42</u>	<u>410</u>
Subtotal	174	1,693
(3) Training	<u>2</u>	<u>18</u>
Subtotal	176	1,711
(4) Mfg. Tech.	<u>3</u>	<u>39</u>
— Subtotal	179	1,750
(5) Q&RA	<u>35</u>	<u>342</u>
Total Mfg. Test Labor	<u><u>214</u></u>	<u><u>2,092</u></u>
Material		11
(6) Q&RA		<u>11</u>
(7) Mfg. Tech.		<u>6</u>
Subtotal		17
(8) Material & Adm. Burden		<u>6</u>
Total Material		<u><u>23</u></u>
Total Mfg. Test Cost		<u><u>\$ 2,115</u></u>

MLLV
PART III
FACILITY LABOR

ENGINE INSTALLATION -E/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.2.4.0-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	<u>88</u>	<u>\$ 855</u>
TOTAL FACILITY LABOR COST		<u>\$ 855</u>

5.2.5 Propellant, Pressurants, and Gases - Injection Stage Engine Module

Propellant costs used on the MLLV engine module were estimated for the following types of propellants:

- a. LOX
- b. LH_2
- c. LN_2
- d. GH_e
- e. GH_2

These costs were based on current actual costs for the Saturn V. An appropriate burden was added to account for the support activities required for procurement.

TABLE 5.2.5.0-I

MLLV COST SUMMARY PROPELLANT - ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									365		365
TOTAL COST									365		365

5.2.6.3 Off Site Support Complex

OFF SITE SUPPORT COMPLEX - ENGINE MODULE - 1 R&D FLIGHT VEHICLES

TABLE 5.2.6.3-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	8	100								8	100
PROGRAM PLAN.& REPT.	21	244								21	244
INDUSTRIAL RELATIONS	5	45								5	45
ENGINEERING			56	661						56	661
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			690	6705						690	6,705
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			133	1295						133	1,295
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	34	389	879	8661						913	9,050
MATERIAL				3							3
LOGISTIC HARDWARE											
BURDEN				1							1
TOTAL MATERIAL				4							4
TOTAL OTHER											
TOTAL COST		389		8,665							9,054

MLLV
RECURRING
PROPELLANT - E/M
(IN THOUSANDS)

TABLE 5.2.5.0-II

	<u>CUBIC FT.</u>	<u>POUNDS</u>	<u>DOLLARS</u>
LOX		1,488	18
LH ₂		259	131
LN ₂		533	14
GHe	1,666		104
GH ₂	408		<u>4</u>
	Propellant Cost		272
	Material and Administrative Burden		93
	TOTAL COST		<u><u>365</u></u>

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5.2.6 Launch Operations - Injection Stage Engine Module

The launch operations for the engine module are divided into two parts. The first part represents the costs for the first and second launches (R&D flight test vehicles). The second part represents the costs for launches of the operational vehicles (third vehicle and subsequent vehicles). Each of these parts are divided into three major categories: 1) Launch Control, 2) Launch Pad Operations, 3) Off Site Support. Figure 5.2.6.0-1 shows the delta costs of these categories and indicates the applicable sub-sections where the costs are shown in detail.

The costs reflected in this section are for launching of one engine module at a two vehicles per year launch rate.

LAUNCH OPERATIONS - ENGINE MODULE - 1 R&D FLIGHT VEHICLE

TABLE 5.2.6.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	14	179								14	179
PROGRAM PLAN.& REPT.	38	438								38	438
INDUSTRIAL RELATIONS	8	81								8	81
ENGINEERING			101	1185						101	1,185
LAB TECHNICIANS											
TOOLING											
PRODUCTION			1237	12025						1,237	12,025
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			239	2322						239	2,322
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	60	698	1577	15532						1,637	16,230
MATERIAL				7							7
LOGISTIC HARDWARE											
BURDEN				1							1
TOTAL MATERIAL				8							8
TOTAL OTHER											
TOTAL COST		698	15540								16,238

LAUNCH OPERATIONS - OPERATIONAL VEHICLES (THIRD VEHICLE
AND SUBSEQUENT VEHICLES)

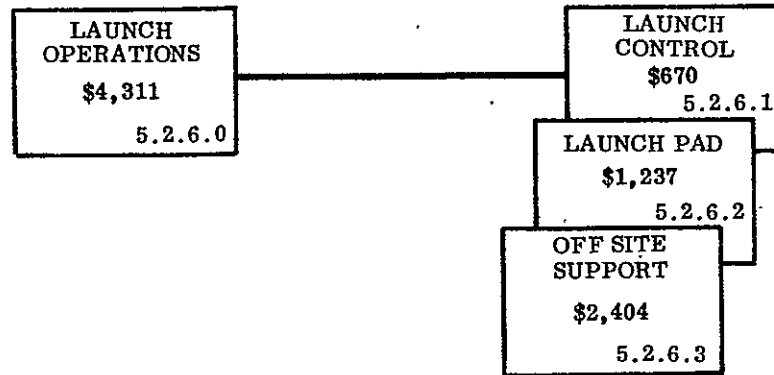
TABLE 5.2.6.0-II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

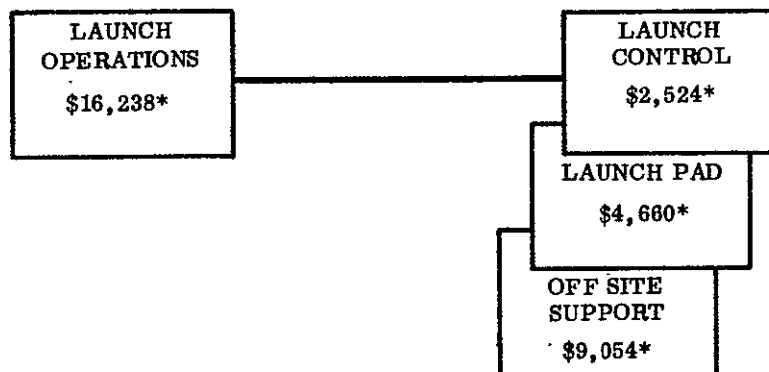
(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	48								4	48
PROGRAM PLAN. & REPT.	10	116								10	116
INDUSTRIAL RELATIONS	2	22								2	22
ENGINEERING			27	315						27	315
LAB TECHNICIANS											
TOOLING											
PRODUCTION			328	3192						328	3,192
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			63	616						63	616
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	16	186	418	4123						434	4,309
MATERIAL				2							2
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				2							2
TOTAL OTHER											
TOTAL COST		186		4125							4,311

**FIXED COSTS - OPERATIONAL VEHICLES
(THIRD VEHICLE AND SUBSEQUENT VEHICLES)**



**(FIXED COSTS - 2 R&D FLIGHT VEHICLES - INCLUDES ADDITIONAL COSTS
FOR 9 MONTH CYCLE TIME. INCREASED SE&I AND INSTRUMENTATION)**



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

*COSTS SHOWN ABOVE ARE
INCREASED BY A FACTOR
OF APPROXIMATELY 3.766
FOR THE FLIGHT TEST VEHICLES

FIGURE 5.2.6.0-1 ENGINE MODULE LAUNCH OPERATIONS COST FLOW DIAGRAM

5.2.6.1 Launch Control Center

LAUNCH CONTROL CENTER - ENGINE MODULE - 1 R&D FLIGHT VEHICLES

TABLE 5.2.6.1-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	28								2	28
PROGRAM PLAN.& REPT.	6	68								6	68
INDUSTRIAL RELATIONS	1	13								1	13
ENGINEERING			16	184						16	184
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			192	1869						192	1,869
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			37	361						37	361
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	9	109	245	2414						254	2,523
MATERIAL				1							1
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				1							1
TOTAL OTHER											
TOTAL COST		109		2415							2524

MLLV
RECURRING
PART I
LAUNCH CONTROL CENTER - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.6.1-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	16		
Logistics			
Laboratory Technician			
Production	192		
Tooling			
Manufacturing Test			
Q&RA	37		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>245</u>		
Program Executive		2	28
Program Planning & Reporting		6	68
Industrial Relations		<u>1</u>	<u>13</u>
Total Labor - Part I		<u>9</u>	<u>109</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>109</u>

LAUNCH CONTROL CENTER-ENGINE MODULE

TABLE 5.2.6.1-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	16	184							16	184
LAB TECHNICIANS										
TOOLING										
PRODUCTION			192	1869					192	1,869
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			37	361					37	361
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	16	184	229	2230					245	2,414
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				1						1
SUBTOTAL				1						1
MAT. & ADM. BURDEN										
TOTAL MATERIAL				1						1
TOTAL PART II COST		184	2231							2,415

MLLV
 RECURRING
 LAUNCH OPERATIONS
 LAUNCH CONTROL CENTER - E/M
TABLE 5.2.6.1-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:	16	184
Design Support		
TOTAL COST	<u>16</u>	<u>184</u>

MLLV
RECURRING
LAUNCH OPERATIONS
LAUNCH CONTROL CENTER - E/M
TABLE 5.2.6.1-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	106	1,028
Technical Support	<u>86</u>	<u>841</u>
Subtotal	192	1,869
Q&RA	<u>37</u>	<u>361</u>
Total Labor	<u>229</u>	<u>2,230</u>
Material		
Q&RA		1
Material and Administrative Burden		<u> </u>
Total Material		
 TOTAL COST		 <u>2,231</u>

5.2.6.2 Launch Pad

LAUNCH PAD - ENGINE MODULE - 1 R&D FLIGHT VEHICLES

TABLE 5.2.6.2-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	51								4	51
PROGRAM PLAN.& REPT.	11	126								11	126
INDUSTRIAL RELATIONS	2	23								2	23
ENGINEERING			29	340						29	340
LAB TECHNICIANS											
TOOLING											
PRODUCTION			355	3451						355	3,451
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			69	666						69	666
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	17	200	453	4457						470	4,657
MATERIAL				3							3
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				3							3
TOTAL OTHER											
TOTAL COST		200		4460							4,660

MLLV
RECURRING
PART I
LAUNCH PAD - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.6.2-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	29		
Logistics			
Laboratory Technician			
Production	355		
Tooling			
Manufacturing Test			
Q&RA	69		
Facilities			
Manufacturing Technician	—		
Total Direct Labor	<u>453</u>		
Program Executive		4	51
Program Planning & Reporting		11	126
Industrial Relations		<u>2</u>	<u>23</u>
Total Labor - Part I		<u>17</u>	<u>200</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
 TOTAL COST - PART I			<u>200</u>

LAUNCH PAD - ENGINE MODULE

TABLE 5.2.6.2-III

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	29	340							29	340
LAB TECHNICIANS										
TOOLING										
PRODUCTION			355	3451					355	3,451
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			69	666					69	666
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	29	340	424	4117					453	4,457
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				3						3
SUBTOTAL				3						3
MAT. & ADM. BURDEN										
TOTAL MATERIAL				3						3
TOTAL PART II COST		340		4120						4,460

MLLV
 RECURRING
 LAUNCH OPERATIONS
 LAUNCH PAD - E/M
 TABLE 5.2.6.2-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	29	340
TOTAL COST	<u>29</u>	<u>340</u>

MLLV
RECURRING
LAUNCH OPERATIONS
LAUNCH PAD - E/M
TABLE 5.2.6.2-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	195	1,898
Technical Support	<u>160</u>	<u>1,553</u>
Subtotal	355	3,451
Q&RA	<u>69</u>	<u>666</u>
Total Labor	<u>424</u>	<u>4,117</u>
Material		
Q&RA		3
Material and Administrative Burden		<u> </u>
Total Material		<u>3</u>
 TOTAL COST		 <u>4,120</u>

5.2.6.3 Off Site Support Complex

OFF SITE SUPPORT COMPLEX - ENGINE MODULE - 1 R&D FLIGHT VEHICLES

TABLE 5.2.6.3-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	8	100								8	100
PROGRAM PLAN.& REPT.	21	244								21	244
INDUSTRIAL RELATIONS	5	45								5	45
ENGINEERING			56	661						56	661
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			690	6705						690	6,705
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			133	1295						133	1,295
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	34	389	879	8661						913	9,050
MATERIAL				3							3
LOGISTIC HARDWARE											
BURDEN				1							1
TOTAL MATERIAL				4							4
TOTAL OTHER											
TOTAL COST		389		8,665							9,054

MLIV
RECURRING
PART I
OFF SITE SUPPORT COMPLEX - E/M
ASSEMBLY OR SYSTEM
TABLE 5.2.6.3-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	56		
Logistics			
Laboratory Technician			
Production	690		
Tooling			
Manufacturing Test			
Q&RA	133		
Facilities			
Manufacturing Technician	—		
Total Direct Labor	<u>879</u>		
Program Executive		8	100
Program Planning & Reporting		21	244
Industrial Relations		<u>5</u>	<u>45</u>
Total Labor - Part I		<u>34</u>	<u>389</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>389</u>

OFF SITE SUPPORT COMPLEX - ENGINE MODULE

TABLE 5.2.6.3-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	56	661							56	661
LAB TECHNICIANS										
TOOLING										
PRODUCTION			690	6705					690	6,705
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			133	1295					133	1,295
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	56	661	823	8000					879	8,661
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				3						3
SUBTOTAL				3						3
MAT. & ADM. BURDEN				1						1
TOTAL MATERIAL				4						4
TOTAL PART II COST		661		8004						8,665

MLLV
 RECURRING
 LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - E/M
 TABLE 5.2.6.3-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	56	661
TOTAL COST	<u>56</u>	<u>661</u>

MLLV
RECURRING
LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - E/M
TABLE 5.2.6.3-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	380	3,688
Technical Support	<u>310</u>	<u>3,017</u>
Subtotal	690	6,705
Q&RA	<u>133</u>	<u>1,295</u>
Total Labor	<u>823</u>	<u>8,000</u>
Material		
Q&RA		3
Material and Administrative Burden		<u>1</u>
Total Material		<u>4</u>
TOTAL COST		<u>8,004</u>

5.2.7 Manufacturing Facility Maintenance and Transportation- Injection Stage Engine Module

Maintenance costs include cost for maintenance of the manufacturing building, the vertical assembly building, post manufacturing and stage test building, the office building and the capital equipment.

Transportation costs include costs for such items as the barges, the tow vehicle, the land transporter, and the cost for the barge trip from the manufacturing facility to the launch site.

TABLE 5.2.7.0-I FACILITIES & TRANSPORTATION
MLLV COST SUMMARY ENGINE MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES						1,310					1,310
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR						1,310					1,310
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST						1,310					1,310

MLLV
RECURRING COST SUMMARY
~~ENGINE MODULE~~

FACILITIES & TRANSPORTATION
(DOLLARS IN THOUSANDS)

TABLE 5.2.7.0-II

<u>Element of Cost.</u>	<u>Facilities</u>	<u>Equipment</u>	<u>Transportation.</u>
Manufacturing Bldg.	1,470	630	
Vertical Assy. Bldg.	37	16	
Post Mfg. & Stage Test Bldg.	21	13	
Liquid Engine Mfg. Bldg.			
Office	<u>365</u>	<u>41</u>	
Subtotal	<u>1,893</u>	<u>700</u>	
<u>Transportation</u>			
Barge			40
Tow Vehicle			2
Land Transporter			<u>4</u>
Subtotal			<u>46</u>
Totals			
Transportation			46
Equipment			700
Facilities			1,893
Barge Trips *			<u>32</u>
MANUFACTURING FACILITIES COST			<u>2,671</u>
Recurring Cost for one vehicle or six (6) months			<u>1,310</u>

* Barge Trips are estimated 4 per year

$$\$8,000 \times 4 = \$32,000$$

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5.3 FUEL MODULE INJECTION STAGE

The summary costs for the first unit injection stage - fuel module are displayed in Figure 5.3.0.0-1. These costs include not only the hardware, but all the costs associated with launching the stage and maintaining that portion of the facility associated with the fuel module. Table 5.3.0.0-I summarizes the cost of the fuel module by part and elements of costs for the first R&D flight vehicles.

Table 5.3.0.0-II displays (for reference) the costs for the first operational vehicle (third unit).

FUEL MODULE - 1' R&D LAUNCH VEHICLE

TABLE 5.3.0.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	6	67								6	67
PROGRAM PLAN.& REPT.	16	170								16	170
INDUSTRIAL RELATIONS	2	30								2	30
ENGINEERING			237	2428				6		237	2,434
LAB TECHNICIANS											
TOOLING			21	397						21	397
PRODUCTION			628	7495						628	7,495
MANUFACTURING TEST			17	298						17	298
MANUFACTURING TECH.			9	98						9	98
Q & R A			91	904						91	904
FACILITIES					8	77				8	77
DIRECT DIST			92	902						92	902
TRAINING			5	51						5	51
TOTAL DIRECT LABOR	24	267	1100	12573	8	77		6		1,132	12,923
MATERIAL				924							924
LOGISTIC HARDWARE								9			9
BURDEN				305							305
TOTAL MATERIAL				1229				9			1,238
TOTAL OTHER									365		365
TOTAL COST		267	13802			77		15	365		14,526

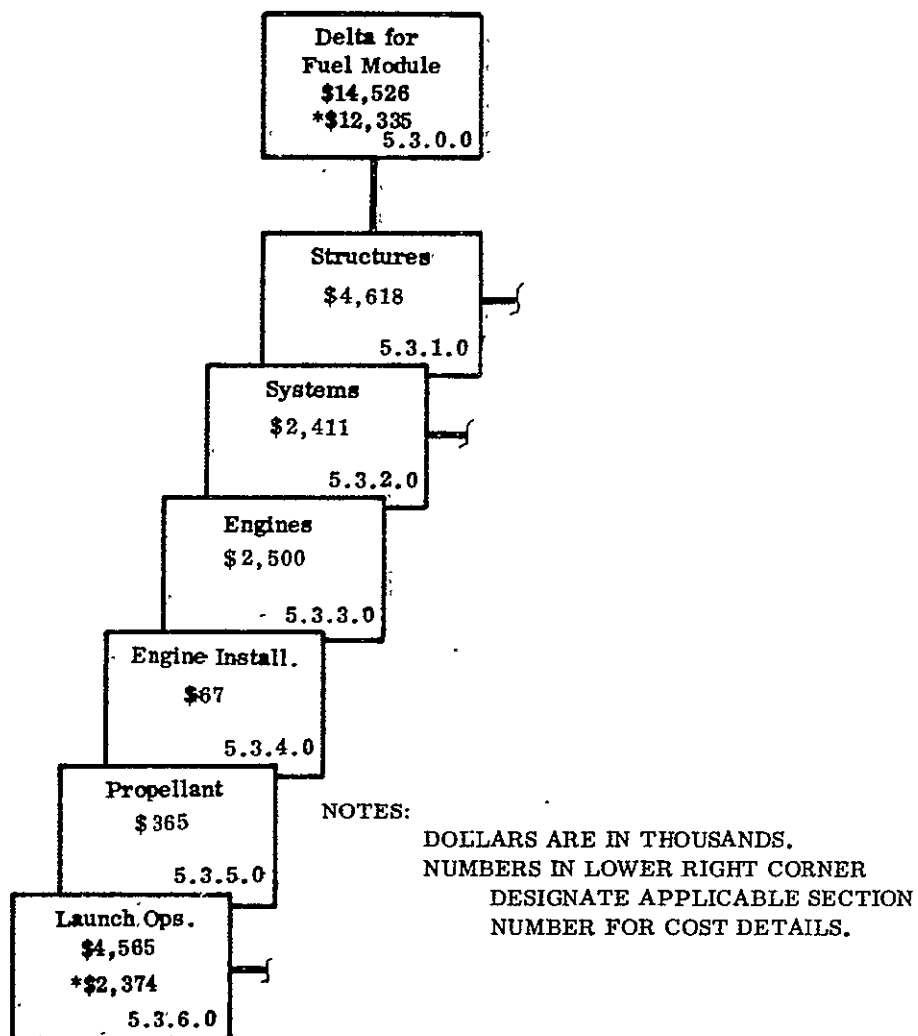
FUEL MODULE - OPERATIONAL VEHICLES
(THIRD VEHICLE AND SUBSEQUENT VEHICLES)

TABLE 5.3.0.0-II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	6	67								6	67
PROGRAM PLAN.& REPT.	16	170								16	170
INDUSTRIAL RELATIONS	2	30								2	30
ENGINEERING			124	1340				6		124	1,346
LAB TECHNICIANS											
TOOLING			21	397						21	397
PRODUCTION			488	6404						488	6,404
MANUFACTURING TEST			17	298						17	298
MANUFACTURING TECH.			9	98						9	98
Q & R A			91	904						91	904
FACILITIES					8	77				8	77
DIRECT DIST			92	902						92	902
TRAINING			-	51						5	51
TOTAL DIRECT LABOR	24	267	847	10394	8	77		6		879	10,744
MATERIAL				912							912
LOGISTIC HARDWARE								9			9
EXPENSES				305							305
TOTAL MATERIAL				1217				9			1,226
TOTAL OTHER									365		365
TOTAL COST		267		11611		77		15	365		12,335



*FIRST OPERATIONAL UNIT COST WHICH DIFFERS
SIGNIFICANTLY FROM THOSE OF FIRST R&D FLIGHT
UNIT

FIGURE 5.3.0.0-1 FUEL MODULE - INJECTION STAGE COST FLOW DIAGRAM

5.3.1 Structures - Injection Stage Fuel Module

The first unit production cost for the structural components of the fuel module are displayed in Figure 5.3.1.0-1. The cost details of the structural components are contained in appropriate sub-sections as indicated.

Table 5.3.1.0-I is a total cost summary of these sections.

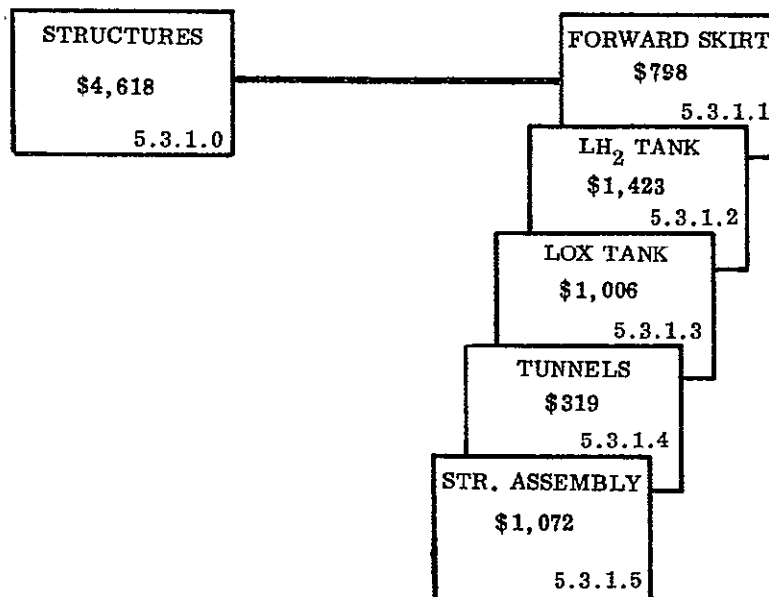
TABLE 5.3.1.0-I
MLLV COST SUMMARY

STRUCTURES - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	4	47								4	47
PROGRAM PLAN.& REPT.	11	120								11	120
INDUSTRIAL RELATIONS	2	23								2	23
ENGINEERING			1	12				6		1	18
LAB TECHNICIANS											
TOOLING			16	160						16	160
PRODUCTION			230	2234						230	2,234
MANUFACTURING TEST			12	121						12	121
MANUFACTURING TECH.			6	69						6	69
Q & R A			65	636						65	636
FACILITIES					6	60				6	60
DIRECT DIST.			66	637						66	637
TRAINING			3	36						3	36
TOTAL DIRECT LABOR	17	190	399	3905	6	60		6		422	4,161
MATERIAL				334							334
LOGISTIC HARDWARE								9			9
BURDEN				114							114
TOTAL MATERIAL				448				9			457
TOTAL OTHER											
TOTAL COST		190		4353		60		15			4,618



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 5.3.1.0-1 FUEL MODULE STRUCTURES COST FLOW DIAGRAM

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5.3.1.1 Forward Skirt - Injection Stage Fuel Module

TABLE 5.3.1.1-I
MLLV COST SUMMARY

FORWARD SKIRT - F/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	7								1	7
PROGRAM PLAN.& REPT.	2	18								2	18
INDUSTRIAL RELATIONS		3									3
ENGINEERING				1							1
LAB TECHNICIANS											
TOOLING			2	21						2	21
PRODUCTION			35	338						35	338
MANUFACTURING TEST			1	16						1	16
MANUFACTURING TECH.			1	11						1	11
Q & R A			10	94						10	94
FACILITIES					1	9				1	9
DIRECT DIST.			10	95						10	95
TRAINING				5							5
TOTAL DIRECT LABOR	3	28	59	581	1	9				63	618
MATERIAL				135							135
LOGISTIC HARDWARE											
BURDEN				45							45
TOTAL MATERIAL				180							180
TOTAL OTHER											
TOTAL COST		28		761		9					798

MLLV
 RECURRING
 PART I
 FORWARD SKIRT - F/M
 ASSEMBLY OR SYSTEM
 TABLE 5.3.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	39		
Logistics	5		
Laboratory Technician	8		
Production	34,790		
Tooling	2,137		
Manufacturing Test	1,620		
Q&RA	9,768		
Facilities	801		
Manufacturing Technician	874		
Total Direct Labor	<u>50,043</u>		
Program Executive		600	7,086
Program Planning & Reporting		1,501	17,727
Industrial Relations		<u>325</u>	<u>3,159</u>
Total Labor - Part I		<u>2,426</u>	<u>27,972</u>
<u>Material</u>			
Program Planning & Reporting			30
Industrial Relations			<u>33</u>
Material Subtotal			63
Material & Administrative Burden			<u>22</u>
Total Material			<u>85</u>
TOTAL COST - PART I			<u>28,057</u>

TABLE 5.3.1.1-III
MLLV PART II COST SUMMARY

FORWARD SKIRT - F/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING		1								1
LAB TECHNICIANS										
TOOLING					2	21			2	21
PRODUCTION			35	338					35	338
MANUFACTURING TEST							1	16	1	16
MANUFACTURING TECH.			1	10				1	1	11
Q & R A			9	85		5	1	4	10	94
DIRECT DIST			8	83	1	7	1	5	10	95
TRAINING				5						5
TOTAL DIRECT LABOR		1	53	521	3	33	3	26	59	581
MATERIAL										
LAB. TECHNICIANS										
TOOLING						4				4
PRODUCTION				127						127
MFG. TECHNICIANS				1						1
Q & R A				3						3
SUBTOTAL				131		4				135
MAT. & ADM. BURDEN				44		1				45
TOTAL MATERIAL				175		5				180
TOTAL PART II COST		1		696		38		26		761

MLLV
PART II
ENGINEERING

FORWARD SKIRT - F/M

ASSEMBLY OR SYSTEM

TABLE 5.3.1.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	38	449
Reliability Engineering	<u>1</u>	<u>12</u>
(1) Subtotal (A)	39	461
(2) Laboratory Technicians	<u>8</u>	<u>94</u>
Subtotal (B)	47	555
(3) Q&RA	<u>2</u>	<u>24</u>
Total Engineering Labor	<u>49</u>	<u>579</u>
Material		
(4) Lab. Tech.		17
(5) Q&RA		<u>1</u>
Subtotal (C)		18
(6) Material & Adm. Burden		<u>6</u>
Total Material		<u>24</u>
Total Engineering Cost		<u>603</u>

MLLV
PART II
MANUFACTURING
PRODUCTION
FORWARD SKIRT - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	24,529	238,422
(2) Miscellaneous Charges	1,913	18,596
(3) Maintain & Add in Scope Changes	270	2,622
Subtotal (A)	26,712	259,641
(4) Tool & Production Planning	8,078	78,515
Subtotal (B)	34,790	338,156
(5) Direct Distributable	8,548	83,085
Subtotal (C)	43,338	421,240
(6) Training	477	4,634
Subtotal (D)	43,814	425,874
(7) Q&RA	8,763	85,174
(8) Mfg. Tech.	832	9,831
Total Production Labor	<u>53,409</u>	<u>520,879</u>
Material		
(9) Raw Material & Standards		126,876
(10) Q&RA		2,629
(11) Mfg. Tech.		1,457
Material Subtotal		130,962
(12) Material & Adm. Burden		44,527
Total Material		<u>175,488</u>
Total Production Cost		<u>696,367</u>

MLLV
PART II
MANUFACTURING
TOOLING

FORWARD SKIRT - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,137	20,772
(2) Direct Distributabel	<u>684</u>	<u>6,647</u>
Subtotal (A)	2,821	27,418
(3) Training	<u>31</u>	<u>301</u>
Subtotal (B)	2,852	27,719
(4) Q&RA	<u>570</u>	<u>5,543</u>
Total Tooling Labor	<u>3,422</u>	<u>33,262</u>
Material		
(5) Tooling		3,740
(6) Q&RA		<u>170</u>
Subtotal (C)		3,910
(7) Material & Adm. Burden		<u>1,330</u>
Total Material		<u>5,240</u>
Total Tooling Cost		<u>38,502</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

FORWARD SKIRT - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,226	11,917
Component Test Planning	392	3,813
(1) Subtotal	1,618	15,730
(2) Direct Distributable	518	5,033
Subtotal	2,136	20,763
(3) Training	23	227
Subtotal	2,159	20,990
(4) Mfg. Tech.	41	584
Subtotal	2,200	21,474
(5) Q&RA	432	4,198
Total Mfg. Test Labor	<u>2,632</u>	<u>25,672</u>
Material		
(6) Q&RA		130
(7) Mfg. Tech.		72
Subtotal		202
(8) Material & Adm. Burden		68
Total Material		<u>270</u>
Total Mfg. Test Cost		<u>25,942</u>

MLLV
PART III
FACILITY LABOR
FORWARD SKIRT - F/M
TABLE 5.3.1.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	802	9,472
Total Facility Labor Cost	<u>802</u>	<u>9,742</u>

MLLV
PART IV
LOGISTIC LABOR
FORWARD SKIRT - F/M

TABLE 5.3.1.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>5</u>	59
(2) Hardware		280
(3) Material & Adm. Burden		<u>95</u>
Total Material		<u>375</u>
Total Logistic Cost		<u>434</u>

5.3.1.2 LH₂ Tank Torus - Injection Stage Fuel Module

TABLE 5.3.1.2-I
MLLV COST SUMMARY

LH₂ TANK - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	14								1	14
PROGRAM PLAN.& REPT.	3	36								3	36
INDUSTRIAL RELATIONS	1	7								1	7
ENGINEERING											
LAB TECHNICIANS											
TOOLING			4	42						4	42
PRODUCTION			70	684						70	684
MANUFACTURING TEST			3	32						3	32
MANUFACTURING TECH.			2	21						2	21
Q & R A			20	192						20	192
FACILITIES					2	16				2	16
DIRECT DIST			20	191						20	191
TRAINING			1	10						1	10
TOTAL DIRECT LABOR	5	57	120	1,172	2	16				127	1,245
MATERIAL				130							130
LOGISTIC HARDWARE							4				4
BURDEN				44							44
TOTAL MATERIAL				174			4				178
TOTAL OTHER											
TOTAL COST		57		1,346		16	4				1,423

MLLV
RECURRING

PART I

LH₂ TANK - F/M
ASSEMBLY OR SYSTEM

TABLE 5.3.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	23		
Logistics	43		
Laboratory Technician	5		
Production	70,325		
Tooling	4,320		
Manufacturing Test	3,272		
Q&RA	19,656		
Facilities	1,620		
Manufacturing Technician	1,766		
Total Direct Labor	101,144		
Program Executive		1,214	14,337
Program Planning & Reporting		3,035	35,843
Industrial Relations		658	6,396
Total Labor - Part I		4,907	56,576
<u>Material</u>			
Program Planning & Reporting			61
Industrial Relations			66
Material Subtotal			127
Material & Administrative Burden			43
Total Material			170
TOTAL COST - PART I			56,746

TABLE 5.3.1.2-III
MLLV PART II COST SUMMARY

LH₂ TANK - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					4	42			4	42
PRODUCTION			70	684					70	684
MANUFACTURING TEST							3	32	3	32
MANUFACTURING TECH.			2	20				1	2	21
Q & R A			18	172	1	11	1	9	20	192
DIRECT DIST			17	168	2	13	1	10	20	191
TRAINING			1	9		1			1	10
TOTAL DIRECT LABGR			108	1,053	7	67	5	52	120	1,172
MATERIAL										
LAB. TECHNICIANS										
TOOLING						8				8
PRODUCTION				114						114
MFG. TECHNICIANS				3						3
Q & R A				5						5
SUBTOTAL				122		8				130
MAT. & ADM. BURDEN				42		2				44
TOTAL MATERIAL				164		10				174
TOTAL PART II COST				1,217		77		52		1,346

MLLV
PART II.
ENGINEERING

LH₂ TANK - F/M

ASSEMBLY OR SYSTEM

TABLE 5.3.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	17	201
Reliability Engineering	<u>6</u>	<u>71</u>
(1) Subtotal (A)	23	272
(2) Laboratory Technicians	<u>5</u>	<u>12</u>
Subtotal (B)	28	330
(3) Q&RA	<u>1</u>	<u>12</u>
Total Engineering Labor	<u>29</u>	<u>342</u>
Material		
(4) Lab. Tech.		11
(5) Q&RA		<u> </u>
Subtotal (C)		11
(6) Material & Adm. Burden		<u>4</u>
Total Material		<u>15</u>
Total Engineering Cost		<u>357</u>

MLLV
PART II
MANUFACTURING
PRODUCTION
LH₂ TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.3.1.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	49,584	481,956
(2) Miscellaneous Charges	3,868	37,592
(3) Maintain & Add in Scope Changes	<u>545</u>	<u>5,301</u>
Subtotal (A)	53,997	524,850
(4) Tool & Production Planning	<u>16,329</u>	<u>158,714</u>
Subtotal (B)	70,326	683,564
(5) Direct Distributable	<u>17,279</u>	<u>167,952</u>
Subtotal (C)	87,605	851,515
(6) Training	<u>964</u>	<u>9,366</u>
Subtotal (D)	88,568	860,882
(7) Q&RA	17,714	172,176
(8) Mfg. Tech.	<u>1,683</u>	<u>19,873</u>
Total Production Labor	<u>107,964</u>	<u>1,052,930</u>
<u>Material</u>		
(9) Raw Material & Standards		114
(10) Q&RA		5
(11) Mfg. Tech.		<u>3</u>
Material Subtotal		122
(12) Material & Adm. Burden		<u>42</u>
Total Material		<u>164</u>
Total Production Cost		<u>1,217</u>

MLLV
PART II
MANUFACTURING
TOOLING

LH₂ TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	4,320	41,990
(2) Direct Distributabel	<u>1,382</u>	<u>13,437</u>
Subtotal (A)	5,702	55,427
(3) Training	<u>63</u>	<u>609</u>
Subtotal (B)	5,765	56,036
(4) Q&RA	<u>1,153</u>	<u>11,207</u>
Total Tooling Labor	<u><u>6,918</u></u>	<u><u>67,243</u></u>
Material		
(5) Tooling		7,560
(6) Q&RA		<u>346</u>
Subtotal (C)		7,906
(7) Material & Adm. Burden		<u>2,688</u>
Total Material		<u><u>10,594</u></u>
Total Tooling Cost		<u><u>77,837</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

LH₂ TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	2,479	24,076
Component Test Planning	<u>793</u>	<u>7,710</u>
(1) Subtotal	3,272	31,806
(2) Direct Distributable	<u>1,047</u>	<u>10,178</u>
Subtotal	4,319	41,984
(3) Training	<u>48</u>	<u>462</u>
Subtotal	4,367	42,446
(4) Mfg. Tech.	<u>83</u>	<u>979</u>
Subtotal	4,450	43,424
(5) Q&RA	<u>873</u>	<u>8,488</u>
Total Mfg. Test Labor	<u>5,323</u>	<u>51,912</u>
Material		
(6) Q&RA		262
(7) Mfg. Tech.		<u>145</u>
Subtotal		407
(8) Material & Adm. Burden		<u>138</u>
Total Material		<u>545</u>
Total Mfg. Test Cost		<u>52,457</u>

MLLV
PART III
FACILITY LABOR
LH₂ TANK - F/M
TABLE 5.3.1.2-VIII

<u>Element of Cost</u>		<u>Manhours</u>	<u>Dollars</u>
(1)	Direct Labor Hours	1,620	\$15,746
	Total Facility Labor Cost	<u>1,620</u>	<u>\$15,746</u>

MLLV
PART IV
LOGISTIC LABOR
LH₂ TANK - F/M
TABLE 5.3.1.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>43</u>	\$ 508
(2) Hardware		2,408
(3) Material & Adm. Burden		<u>818</u>
Total Material		<u>\$3,226</u>
Total Logistic Cost		<u>\$3,774</u>

5.3.1.3 LOX Tank Torus - Injection Stage Fuel Module

TABLE 5.3.1.3-I
MLLV COST SUMMARY

LOX TANK - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	11								1	11
PROGRAM PLAN. & REPT.	2	27								2	27
INDUSTRIAL RELATIONS	1	5								1	5
ENGINEERING								4			
LAB TECHNICIANS											
TOOLING			3	32						3	32
PRODUCTION			53	514						53	514
MANUFACTURING TEST			2	24						2	24
MANUFACTURING TECH.			1	16						1	16
Q & R A			15	143						15	143
FACILITIES					1	12				1	12
DIRECT DIST			15	144						15	144
TRAINING			1	9						1	9
TOTAL DIRECT LABOR	4	43	90	882	1	12		4		95	941
MATERIAL				48							48
LOGISTIC HARDWARE											
BURDEN				17							17
TOTAL MATERIAL				65							65
TOTAL OTHER											
TOTAL COST		43		947		12		4			1,006

MLLV
RECURRING
PART I

LOX TANK - F/M
ASSEMBLY OR SYSTEM
1ST UNIT

TABLE 5.3.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	23		
Logistics	43		
Laboratory Technician	2		
Production	52,881		
Tooling	3,248		
Manufacturing Test	2,460		
Q&RA	14,843		
Facilities	1,218		
Manufacturing Technician	1,327		
Total Direct Labor	76,051		
Program Executive		912	10,771
Program Planning & Reporting		2,282	26,950
Industrial Relations		495	4,811
Total Labor - Part I		3,689	42,532
<u>Material</u>			
Program Planning & Reporting			43
Industrial Relations			50
Material Subtotal			93
Material & Administrative Burden			34
Total Material			127
TOTAL COST - PART I			42,659

TABLE 5.3.1.3-III

LOX TANK - F/M

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					3	32			3	32
PRODUCTION			53	514					53	514
MANUFACTURING TEST							2	24	2	24
MANUFACTURING TECH.			1	15				1	1	16
Q & R A			13	129	1	8	1	6	15	143
DIRECT DIST			13	126	1	10	1	8	15	144
TRAINING			1	8		1			1	9
TOTAL DIRECT LABOR			81	792	5	51	4	39	90	882
MATERIAL										
LAB. TECHNICIANS										
TOOLING						5				5
PRODUCTION				37						37
MFG. TECHNICIANS				2						2
Q & R A				4						4
SUBTOTAL				43		5				48
MAT. & ADM. BURDEN				15		2				17
TOTAL MATERIAL				58		7				65
TOTAL PART II COST				850		58		39		947

MLLV
PART II
ENGINEERING

LOX TANK - F/M

ASSEMBLY OR SYSTEM

TABLE 5.3.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	17	201
Reliability Engineering	<u>6</u>	<u>71</u>
(1) Subtotal (A)	23	272
(2) Laboratory Technicians	<u>5</u>	<u>59</u>
Subtotal (B)	28	331
(3) Q&RA	<u>1</u>	<u>10</u>
Total Engineering Labor	<u>29</u>	<u>341</u>
Material		
(4) Lab. Tech.		11
(5) Q&RA		<u> </u>
Subtotal (C)		11
(6) Material & Adm. Burden		<u>3</u>
Total Material		<u>14</u>
Total Engineering Cost		<u>355</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

LOX TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.3.1.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	37,284	362,400
(2) Miscellaneous Charges	2,908	28,267
(3) Maintain & Add in Scope Changes	<u>410</u>	<u>3,986</u>
Subtotal (A)	40,602	394,653
(4) Tool & Production Planning	<u>12,278</u>	<u>119,343</u>
Subtotal (B)	52,880	513,996
(5) Direct Distributable	<u>12,993</u>	<u>126,289</u>
Subtotal (C)	65,873	640,285
(6) Training	<u>725</u>	<u>7,043</u>
Subtotal (D)	66,598	647,328
(7) Q&RA	13,320	129,466
(8) Mfg. Tech.	<u>1,265</u>	<u>14,943</u>
Total Production Labor	<u>81,182</u>	<u>791,737</u>
Material		
(9) Raw Material & Standards		37,137
(10) Q&RA		3,996
(11) Mfg. Tech.		<u>2,214</u>
Material Subtotal		43,347
(12) Material & Adm. Burden		<u>14,738</u>
Total Material		<u>58,085</u>
Total Production Cost		<u>849,822</u>

MLLV
PART II.
MANUFACTURING
TOOLING

LOX TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	3,248	31,571
(2) Direct Distributabel	<u>1,039</u>	<u>10,102</u>
Subtotal (A)	4,287	41,673
(3) Training	<u>47</u>	<u>458</u>
Subtotal (B)	4,334	42,131
(4) Q&RA	<u>867</u>	<u>8,425</u>
Total Tooling Labor	<u>5,201</u>	<u>50,556</u>
Material		
(5) Tooling		5,684
(6) Q&RA		<u>260</u>
Subtotal (C)		5,944
(7) Material & Adm. Burden		<u>2,021</u>
Total Material		<u>7,965</u>
Total Tooling Cost		<u>58,521</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
LOX TANK - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,864	18,118
Component Test Planning	<u>596</u>	<u>5,797</u>
(1) Subtotal	2,460	23,915
(2) Direct Distributable	<u>787</u>	<u>7,653</u>
Subtotal	3,247	31,568
(3) Training	<u>36</u>	<u>347</u>
Subtotal	3,283	31,915
(4) Mfg. Tech.	<u>62</u>	<u>736</u>
Subtotal	3,345	32,651
(5) Q&RA	<u>657</u>	<u>6,382</u>
Total Mfg. Test Labor	<u><u>4,002</u></u>	<u><u>39,033</u></u>
Material		
(6) Q&RA		197
(7) Mfg. Tech.		<u>109</u>
Subtotal		306
(8) Material & Adm. Burden		<u>104</u>
Total Material		<u><u>410</u></u>
Total Mfg. Test Cost		<u><u>39,443</u></u>

MLLV
 PART III
 FACILITY LABOR
 LOX TANK - F/M
 TABLE 5.3.1.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,218	11,839
Total Facility Labor Cost	<u>1,218</u>	<u>11,839</u>

MLLV
 PART IV
 LOGISTIC LABOR
 LOX TANK - F/M
 TABLE 5.3.1.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>43</u>	508
(2) Hardware		2,408
(3) Material & Adm. Burden		<u>819</u>
Total Material		<u>3,227</u>
Total Logistic Cost		<u>3,735</u>

5.3.1.4 Tunnels - Injection Stage Fuel Module

TUNNELS - FORWARD MODULE

TABLE 5.3.1.4-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		3									3
PROGRAM PLAN.& REPT.	1	9								1	9
INDUSTRIAL RELATIONS		2									2
ENGINEERING				3				2			5
LAB TECHNICIANS											
TOOLING			1	10						1	10
PRODUCTION			17	165						17	165
MANUFACTURING TEST			1	8						1	8
MANUFACTURING TECH.			1	5						1	5
Q & R A			4	47						4	47
FACILITIES					4						4
DIRECT DIST			5	45						5	45
TRAINING				3							3
TOTAL DIRECT LABOR	1	14	29	286	4		2			30	306
MATERIAL				9							9
LOGISTIC HARDWARE											
BURDEN				4							4
TOTAL MATERIAL				13							13
TOTAL OTHER											
TOTAL COST		14		299	4		2				319

MLLV
RECURRING
PART I
TUNNELS - F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	191		
Logistics	29		
Laboratory Technician	38		
Production	16,977		
Tooling	1,043		
Manufacturing Test	791		
Q&RA	4,774		
Facilities	391		
Manufacturing Technician	426		
Total Direct Labor	<u>24,658</u>		
Program Executive		296	3,494
Program Planning & Reporting		740	8,736
Industrial Relations		160	1,558
Total Labor - Part I		<u>1,196</u>	<u>13,788</u>
<u>Material</u>			
Program Planning & Reporting			15
Industrial Relations			16
Material Subtotal			31
Material & Administrative Burden			9
Total Material			<u>40</u>
TOTAL COST - PART I			<u>13,828</u>

TABLE 5.3.1.4-III

TUNNELS - F/M

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING		3								3
LAB TECHNICIANS										
TOOLING					1	10			1	10
PRODUCTION			17	165					17	165
MANUFACTURING TEST							1	8	1	8
MANUFACTURING TECH.			1	5					1	5
Q & R A			4	42		3		2	4	47
DIRECT DIST			4	40	1	3		2	5	45
TRAINING				2				1		3
TOTAL DIRECT LABOR		3	26	254	2	16	1	13	29	286
MATERIAL										
LAB. TECHNICIANS										
TOOLING						2				2
PRODUCTION				7						7
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				7		2				9
MAT. & ADM. BURDEN				3		1				4
TOTAL MATERIAL				10		3				13
TOTAL PART II COST		3		264		19		13		299

MLIV
PART II
ENGINEERING
TUNNELS - F/M

ASSEMBLY OR SYSTEM
TABLE 5.3.1.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	187	2,208
Reliability Engineering	<u>4</u>	<u>48</u>
(1) Subtotal (A)	191	2,256
(2) Laboratory Technicians	<u>43</u>	<u>508</u>
Subtotal (B)	234	2,764
(3) Q&RA	<u>8</u>	<u>94</u>
Total Engineering Labor	<u>242</u>	<u>2,858</u>
Material		
(4) Lab. Tech.		90
(5) Q&RA		<u> </u>
Subtotal (C)		90
(6) Material & Adm. Burden		<u>33</u>
Total Material		<u>123</u>
Total Engineering Cost		<u>2,981</u>

MLLV
PART II
MANUFACTURING
PRODUCTION

TUNNELS - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.3.1.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	11,970	116,348
(2) Miscellaneous Charges	934	9,075
(3) Maintain & Add in Scope Changes	132	1,279
Subtotal (A)	13,035	126,702
(4) Tool & Production Planning	3,942	38,314
Subtotal (B)	16,977	165,016
(5) Direct Distributable	4,171	40,544
Subtotal (C)	21,148	205,560
(6) Training	233	2,261
Subtotal (D)	21,381	207,821
(7) Q&RA	4,276	41,564
(8) Mfg. Tech.	406	4,797
Total Production Labor	26,063	254,182
<u>Material</u>		
(9) Raw Material & Standards		5,716
(10) Q&RA		1,283
(11) Mfg. Tech.		711
Material Subtotal		7,710
(12) Material & Adm. Burden		2,621
Total Material		10,331
Total Production Cost		264,513

MLLV
PART II
MANUFACTURING
TOOLING

TUNNELS - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	1,043	10,138
(2) Direct Distributabel	<u>334</u>	<u>3,243</u>
Subtotal (A)	1,377	13,381
(3) Training	<u>15</u>	<u>147</u>
Subtotal (B)	1,392	13,528
(4) Q&RA	<u>278</u>	<u>2,705</u>
Total Tooling Labor	<u><u>1,670</u></u>	<u><u>16,233</u></u>
Material		
(5) Tooling		1,825
(6) Q&RA		<u>84</u>
Subtotal (C)		1,909
(7) Material & Adm. Burden		<u>649</u>
Total Material		<u><u>2,558</u></u>
Total Tooling Cost		<u><u>18,791</u></u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

TUNNELS - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	599	5,822
Component Test Planning	192	1,562
(1) Subtotal	791	7,684
(2) Direct Distributable	253	2,458
Subtotal	1,044	10,142
(3) Training	11	111
Subtotal	1,055	10,253
(4) Mfg. Tech.	20	236
Subtotal	1,075	10,489
(5) Q&RA	211	2,050
Total Mfg. Test Labor	1,286	12,539
Material		
(6) Q&RA		63
(7) Mfg. Tech.		35
Subtotal		98
(8) Material & Adm. Burden		33
Total Material		131
Total Mfg. Test Cost		12,670

MLLV
PART III
FACILITY LABOR

TUNNELS - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	391	\$3,800
TOTAL FACILITY LABOR COST	<u>391</u>	<u>\$3,800</u>

MLLV
PART IV
LOGISTIC LABOR
TUNNELS - F/M

TABLE 5.3.1.4-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>29</u>	342
(2) Hardware	—	1,624
(3) Material & Adm. Burden		<u>552</u>
Total Material		<u>2,176</u>
Total Logistic Cost		<u>2,498</u>

5.3.1.5 Structure Assembly - Injection Stage Fuel Module

TABLE 5.3.1.5-I
MLLV COST SUMMARY

STRUCTURES ASSEMBLY - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	12								1	12
PROGRAM PLAN.& REPT.	3	30								3	30
INDUSTRIAL RELATIONS		6									6
ENGINEERING			1	8						1	8
LAB TECHNICIANS											
TOOLING			6	55						6	55
PRODUCTION			55	533						55	533
MANUFACTURING TEST			4	41						5	41
MANUFACTURING TECH.			1	16						1	16
Q & R A			16	160						16	160
FACILITIES					2	19				2	19
DIRECT DIST			16	162						16	162
TRAINING			1	9						1	9
TOTAL DIRECT LABOR	4	48	101	984	2	19				107	1,051
MATERIAL				12							12
LOGISTIC HARDWARE								5			5
BURDEN				4							4
TOTAL MATERIAL				16				5			21
TOTAL OTHER											
TOTAL COST		48		1,000		19		5			1,072

MLLV
RECURRING

PART I

STRUCTURES ASSEMBLY - F/M

ASSEMBLY OR SYSTEM

TABLE 5.3.1.5-II

(In Thousands)

Element of Cost Manhours Manhours : Dollars

Direct Labor

Engineering	1
Logistics	
Laboratory Technician	
Production	55
Tooling	6
Manufacturing Test	5
Q&RA	16
Facilities	2
Manufacturing Technician	1

Total Direct Labor	<u>86</u>
--------------------	-----------

Program Executive	1,032	12,188
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Program Planning & Reporting	2,580	30,470
------------------------------	-------	--------

Industrial Relations	<u>559</u>	<u>5,430</u>
----------------------	------------	--------------

Total Labor - Part I	<u>4,171</u>	<u>48,088</u>
----------------------	--------------	---------------

Material

Program Planning & Reporting	51
------------------------------	----

Industrial Relations	<u>56</u>
----------------------	-----------

Material Subtotal	107
-------------------	-----

Material & Administrative Burden	<u>35</u>
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Total Material	<u>142</u>
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TOTAL COST - PART I	<u>48,230</u>
---------------------	---------------

TABLE 5.3.1.5-III

STRUCTURE ASSEMBLY - F/M

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	1	8							1	8
LAB TECHNICIANS										
TOOLING					6	55			6	55
PRODUCTION			55	533					55	533
MANUFACTURING TEST							5	41	5	41
MANUFACTURING TECH.			1	15				1	1	16
Q & R A			14	134	1	15	1	11	16	160
DIRECT DIST			13	131	2	17	1	14	16	162
TRAINING			1	8				1	1	9
TOTAL DIRECT LABOR	1	8	84	821	9	87	7	68	101	984
MATERIAL										
LAB. TECHNICIANS										
TOOLING						7				7
PRODUCTION										
MFG. TECHNICIANS				1						1
Q & R A				3		1				4
SUBTOTAL				4		8				12
MAT. & ADM. BURDEN				2		2				4
TOTAL MATERIAL				6		10				16
TOTAL PART II COST		8		827		97		68		1,000

MLIV
PART II
ENGINEERING

STRUCTURE ASSEMBLY - F/M

ASSEMBLY OR SYSTEM

TABLE 5.3.1.5-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	532	6,283
Reliability Engineering	<u>10</u>	<u>118</u>
(1) Subtotal (A)	542	6,401
(2) Laboratory Technicians	<u>108</u>	<u>1,050</u>
Subtotal (B)	650	7,451
(3) Q&RA	<u>21</u>	<u>204</u>
Total Engineering Labor	<u>671</u>	<u>7,655</u>
Material		
(4) Lab. Tech.		227
(5) Q&RA		<u> </u>
Subtotal (C)		227
(6) Material & Adm. Burden		<u>77</u>
Total Material		<u>304</u>
Total Engineering Cost		<u>7,960</u>

MLLV
PART II.
MANUFACTURING
PRODUCTION

STRUCTURES ASSEMBLY - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.5-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	38,647	375,649
(2) Miscellaneous Charges	3,014	29,296
(3) Maintain & Add in Scope Changes	425	4,131
Subtotal (A)	42,086	409,076
(4) Tool & Production Planning	12,728	123,716
Subtotal (B)	54,814	532,792
(5) Direct Distributable	13,467	130,899
Subtotal (C)	68,281	663,691
(6) Training	751	7,300
Subtotal (D)	69,032	670,991
(7) Q&RA	13,806	134,194
(8) Mfg. Tech.	1,312	15,495
Total Production Labor	84,150	820,684
Material		
(9) Raw Material & Standards		3,141
(10) Q&RA		1,295
(11) Mfg. Tech.		4,436
Material Subtotal		2,189
(12) Material & Adm. Burden		6,625
Total Material		827,309
Total Production Cost		

MLLV
PART II.
MANUFACTURING
TOOLING

STRUCTURE ASSEMBLY - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.1.5-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	5,618	54,607
(2) Direct Distributabel	<u>1,798</u>	<u>17,477</u>
Subtotal (A)	7,416	72,084
(3) Training	<u>82</u>	<u>797</u>
Subtotal (B)	7,498	72,881
(4) Q&RA	<u>1,500</u>	<u>14,580</u>
Total Tooling Labor	<u>8,998</u>	<u>87,461</u>
Material		
(5) Tooling		6,854
(6) Q&RA		<u>450</u>
Subtotal (C)		7,304
(7) Material & Adm. Burden		<u>2,484</u>
Total Material		<u>9,788</u>
Total Tooling Cost		<u>97,249</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
STRUCTURES ASSEMBLY - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.3.1.5-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	3,225	31,347
Component Test Planning	<u>1,033</u>	<u>10,041</u>
(1) Subtotal	4,258	41,388
(2) Direct Distributable	<u>1,364</u>	<u>13,258</u>
Subtotal	5,622	54,646
(3) Training	<u>62</u>	<u>602</u>
Subtotal	5,684	55,248
(4) Mfg. Tech.	<u>106</u>	<u>1,252</u>
Subtotal	5,790	56,500
(5) Q&RA	<u>1,136</u>	<u>11,040</u>
Total Mfg. Test Labor	<u><u>6,926</u></u>	<u><u>67,540</u></u>
Material		
(6) Q&RA		341
(7) Mfg. Tech.		<u>189</u>
Subtotal		530
(8) Material & Adm. Burden		<u>181</u>
Total Material		<u><u>710</u></u>
Total Mfg. Test Cost		<u><u>68,250</u></u>

MLLV
 PART III
 FACILITY LABOR
 STRUCTURES ASSEMBLY - F/M

TABLE 5.3.1.5-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,913	18,594
Total Facility Labor Cost	<u>1,913</u>	<u>18,594</u>

MLLV
PART IV
LOGISTIC LABOR
STRUCTURE ASSEMBLY - F/M
TABLE 5.3.1.5-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>63</u>	744
(2) Hardware		3,528
(3) Material & Adm. Burden		<u>1,200</u>
Total Material		<u>4,728</u>
Total Logistic Cost		<u>5,472</u>

5.3.2 Systems - Injection Stage Fuel Module

The total first production unit cost of the systems for a fuel module and the components thereof are displayed in Figure 5.3.2.0-1. Table 5.3.2.0-I is a total cost summary of the systems. Supporting documentation for each of the major components that are include in this cost summary are in the appropriate sub-paragraphs.

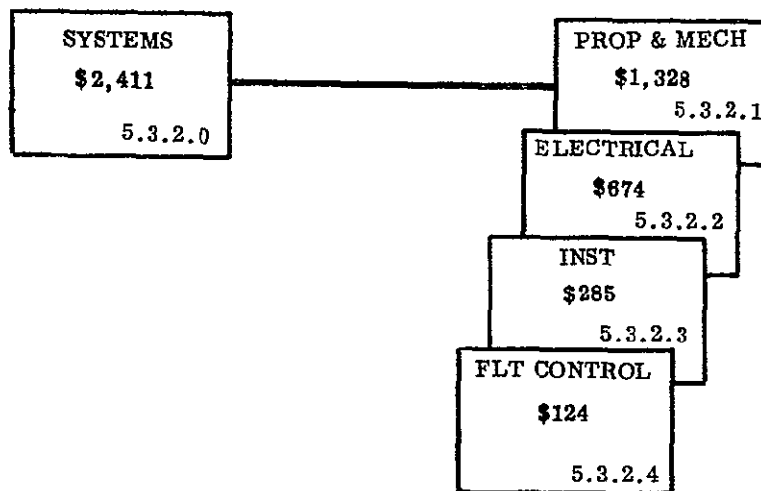
TABLE 5.3.2.0-I

MLLV COST SUMMARY "SYSTEMS - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	2	20								2	20
PROGRAM PLAN.& REPT.	5	48								5	48
INDUSTRIAL RELATIONS		7									7
ENGINEERING											
LAB TECHNICIANS											
TOOLING			5	55						5	55
PRODUCTION			103	910						103	910
MANUFACTURING TEST			5	45						5	45
MANUFACTURING TECH.			3	28						3	28
Q & R A			25	258						25	258
FACILITIES					2	16				2	16
DIRECT DIST			25	255						25	255
TRAINING			2	14						2	14
TOTAL DIRECT LABOR	7	75	168	1,565	2	16				177	1,656
MATERIAL				564							564
LOGISTIC HARDWARE											
BURDEN				191							191
TOTAL MATERIAL				755							755
TOTAL OTHER											
TOTAL COST		75		2,320		16					2,411



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

FIGURE 5.3.2.0-1 FUEL MODULE SYSTEMS COST FLOW DIAGRAM

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5.3.2.1 Propulsion/Mechanical System ~ Injection Stage Fuel Module

PROPULSION AND MECHANICAL - FUEL MODULE

TABLE 5.3.2.1-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	8								1	8
PROGRAM PLAN.& REPT.	2	19								2	19
INDUSTRIAL RELATIONS		3									3
ENGINEERING											
LAB TECHNICIANS											
TOOLING			2	22						2	22
PRODUCTION			47	367						47	367
MANUFACTURING TEST			2	17						2	17
MANUFACTURING TECH.			1	11						1	11
Q & R A			10	103						10	103
FACILITIES					1	8				1	8
DIRECT DIST			10	103						10	103
TRAINING			1	6						1	6
TOTAL DIRECT LABOR	3	30	73	629	1	8				77	667
MATERIAL				493							493
LOGISTIC HARDWARE											
BURDEN				168							168
TOTAL MATERIAL				661							661
TOTAL OTHER											
TOTAL COST		30		1,290		8					1,328

MLLV

PART I

PROPULSION & MECHANICAL - F/M
ASSEMBLY OR SYSTEM
 TABLE 5.3.2.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	37,731		
Tooling	2,317		
Manufacturing Test	1,756		
Q&RA	10,591		
Facilities	870		
Manufacturing Technician	947		
Total Direct Labor	<u>54,217</u>		
Program Executive		651	7,682
Program Planning & Reporting		1,626	19,207
Industrial Relations		<u>352</u>	<u>3,425</u>
Total Labor - Part I		<u>2,629</u>	<u>30,314</u>
<u>Material</u>			
Program Planning & Reporting			32
Industrial Relations			<u>35</u>
Material Subtotal			67
Material & Administrative Burden			<u>23</u>
Total Material			<u>90</u>
TOTAL COST - PART I			<u>30,404</u>

TABLE 5.3.2.1-III

PROPULSION & MECHANICAL SYSTEM - F/M

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					2	23			2	22
PRODUCTION			47	367					47	367
MANUFACTURING TEST							2	17	2	17
MANUFACTURING TECH.			1	11				1	1	11
Q & R A			10	92	1	6		5	10	103
DIRECT DIST			9	90	1	7	1	5	10	103
TRAINING				5					1	6
TOTAL DIRECT LABOR			67	565	4	36	3	28	73	629
MATERIAL										
LAB. TECHNICIANS										
TOOLING						4				4
PRODUCTION				484						484
MFG. TECHNICIANS				2						2
Q & R A				3						3
SUBTOTAL				489		4				493
MAT. & ADM. BURDEN				166		2				168
TOTAL MATERIAL				655		6				661
TOTAL PART II COST				1,220		42		28		1,290

MLLV
PART II
MANUFACTURING
PRODUCTION

PROPULSION & MECHANICAL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	26,603	258,581
(2) Miscellaneous Charges	2,075	20,169
(3) Maintain & Add in Scope Changes	<u>293</u>	<u>2,845</u>
Subtotal (A)	28,971	281,595
(4) Tool & Production Planning	<u>8,761</u>	<u>85,154</u>
Subtotal (B)	37,731	366,749
(5) Direct Distributable	<u>9,271</u>	<u>90,110</u>
Subtotal (C)	105,665	456,860
(6) Training	<u>517</u>	<u>5,025</u>
Subtotal (D)	47,519	461,885
(7) Q&RA	9,504	92,377
(8) Mfg. Tech.	<u>903</u>	<u>10,663</u>
Total Production Labor	<u>57,926</u>	<u>564,925</u>
Material		
(9) Raw Material & Standards		484,232
(10) Q&RA		2,851
(11) Mfg. Tech.		<u>1,580</u>
Material Subtotal		488,663
(12) Material & Adm. Burden		<u>166,145</u>
Total Material		<u>654,808</u>
Total Production Cost		<u>1,219,733</u>

MLIV
PART II
MANUFACTURING
TOOLING

PROPULSION & MECHANICAL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,317	22,521
(2) Direct Distributabel	<u>741</u>	<u>7,207</u>
Subtotal (A)	3,058	29,728
(3) Training	<u>33</u>	<u>324</u>
Subtotal (B)	3,092	30,055
(4) Q&RA	<u>1,382</u>	<u>6,010</u>
Total Tooling Labor	<u><u>3,710</u></u>	<u><u>36,065</u></u>
Material		
(5) Tooling		4,055
(6) Q&RA		<u>186</u>
Subtotal (C)		4,241
(7) Material & Adm. Burden		<u>1,441</u>
Total Material		<u><u>5,682</u></u>
Total Tooling Cost		<u><u>41,747</u></u>

PART II
MANUFACTURING
MANUFACTURING TEST

PROPULSION & MECHANICAL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,330	12,928
Component Test Planning	426	4,136
(1) Subtotal	1,756	17,064
(2) Direct Distributable	562	5,461
Subtotal	2,318	22,525
(3) Training	26	248
Subtotal	2,344	22,773
(4) Mfg. Tech.	44	525
Subtotal	2,388	23,298
(5) Q&RA	469	4,555
Total Mfg. Test Labor	2,857	27,853
Material		
(6) Q&RA		141
(7) Mfg. Tech.		78
Subtotal		219
(8) Material & Adm. Burden		75
Total Material		294
Total Mfg. Test Cost		28,147

MLLV
PART III
FACILITY LABOR
PROPULSION & MECHANICAL SYSTEM - F/M

TABLE 5.3.2.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	870	8,457
Total Facility Labor Cost	<u>870</u>	<u>8,457</u>

5.3.2.2 Electrical System - Injection Stage Fuel Module

TABLE 5.3.2.2-I
MLLV COST SUMMARY

ELECTRICAL - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	8								1	8
PROGRAM PLAN.& REPT.	2	19								2	19
INDUSTRIAL RELATIONS		3									3
ENGINEERING											
LAB TECHNICIANS											
TOOLING			2	22						2	22
PRODUCTION			37	357						37	357
MANUFACTURING TEST			2	17						2	17
MANUFACTURING TECH.			1	11						1	11
Q & R A			10	100						10	100
FACILITIES					1	8				1	8
DIRECT DIST			10	100						10	100
TRAINING			1	5						1	5
TOTAL DIRECT LABOR	3	30	63	612	1	8				67	650
MATERIAL				18							18
LOGISTIC HARDWARE											
BURDEN				6							6
TOTAL MATERIAL				24							24
TOTAL OTHER											
TOTAL COST		30		636		8					674

MLLV

PART I

ELECTRICAL - F/M
ASSEMBLY OR SYSTEM

TABLE 5.3.2.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	37		
Tooling	2		
Manufacturing Test	2		
Q&RA	10		
Facilities	1		
Manufacturing Technician	1		
Total Direct Labor	<u>53</u>		
Program Executive		1	8
Program Planning & Reporting		2	19
Industrial Relations			<u>3</u>
Total Labor - Part I		<u>3</u>	<u>30</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>30</u>

ELECTRICAL - F/M

TABLE 5.3.2.2-III

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					2	22			2	22
PRODUCTION			37	358					37	358
MANUFACTURING TEST							2	17	2	17
MANUFACTURING TECH.			1	10					1	10
Q & R A			9	90	1	6		5	10	101
DIRECT DIST			9	88	1	7	1	5	11	100
TRAINING				5						5
TOTAL DIRECT LABOR			56	551	4	35	3	27	63	613
MATERIAL										
LAB. TECHNICIANS										
TOOLING						4				4
PRODUCTION				9						9
MFG. TECHNICIANS				2						2
Q & R A				3						3
SUBTOTAL				14		4				18
MAT. & ADM. BURDEN				4		1				5
TOTAL MATERIAL				18		5				23
TOTAL PART II COST				569		40		27		636

PART II
MANUFACTURING
PRODUCTION

ELETRICAL - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	25,942	252,157
(2) Miscellaneous Charges	2,023	19,667
(3) Maintain & Add in Scope Changes	286	2,774
Subtotal (A)	28,251	274,598
(4) Tool & Production Planning	8,543	83,038
Subtotal (B)	36,794	357,636
(5) Direct Distributable	9,040	87,872
Subtotal (C)	45,843	445,508
(6) Training	504	4,901
Subtotal (D)	46,338	450,409
(7) Q&RA	9,268	90,081
(8) Mfg. Tech.	880	10,398
Total Production Labor	<u>56,487</u>	<u>550,888</u>
<u>Material</u>		
(9) Raw Material & Standards		8,847
(10) Q&RA		2,780
(11) Mfg. Tech.		1,541
Material Subtotal		13,168
(12) Material & Adm. Burden		4,477
Total Material		<u>17,645</u>
Total Production Cost		<u>568,533</u>

MLLV
PART II
MANUFACTURING
TOOLING

ELECTRICAL - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	2,260	21,967
(2) Direct Distributabel	<u>723</u>	<u>7,029</u>
Subtotal (A)	2,983	28,996
(3) Training	<u>33</u>	<u>319</u>
Subtotal (B)	3,016	29,315
(4) Q&RA	<u>603</u>	<u>5,863</u>
Total Tooling Labor	<u>3,619</u>	<u>35,178</u>
Material		
(5) Tooling		3,955
(6) Q&RA		<u>181</u>
Subtotal (C)		4,136
(7) Material & Adm. Burden		<u>1,407</u>
Total Material		<u>5,543</u>
Total Tooling Cost		<u>40,721</u>

PART II
MANUFACTURING
MANUFACTURING TEST

ELECTRICAL - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	1,297	12,607
Component Test Planning	<u>415</u>	<u>4,035</u>
(1) Subtotal	1,712	16,642
(2) Direct Distributable	<u>548</u>	<u>5,326</u>
Subtotal	2,260	21,968
(3) Training	<u>25</u>	<u>.242</u>
Subtotal	2,285	22,210
(4) Mfg. Tech.	<u>43</u>	<u>512</u>
Subtotal	2,328	22,722
(5) Q&RA	<u>457</u>	<u>4,442</u>
Total Mfg. Test Labor	<u><u>2,785</u></u>	<u><u>27,164</u></u>
Material		137
(6) Q&RA		<u>76</u>
(7) Mfg. Tech.		<u>213</u>
Subtotal		<u>75</u>
(8) Material & Adm. Burden		<u>288</u>
Total Material		<u><u>27,452</u></u>
Total Mfg. Test Cost		<u><u>27,452</u></u>

PART III
FACILITY LABOR

ELECTRICAL - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	848	8,243
TOTAL FACILITY LABOR COST	<u>848</u>	<u>8,243</u>

5.3.2.3 Instrumentation - Injection Stage Fuel Module

TABLE 5.3.2.3-I

MLLV COST SUMMARY

INSTRUMENTATION - F/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		3									3
PROGRAM PLAN.& REPT.	1	8								1	8
INDUSTRIAL RELATIONS		1									1
ENGINEERING											
LAB TECHNICIANS											
TOOLING			1	9						1	9
PRODUCTION			15	145						15	145
MANUFACTURING TEST			1	7						1	7
MANUFACTURING TECH.				5							5
Q & R A			4	41						4	41
FACILITIES						3					3
DIRECT DIST			4	40						4	40
TRAINING				2							2
TOTAL DIRECT LABOR	1	12	25	249		3				26	264
MATERIAL				16							16
LOGISTIC HARDWARE											
BURDEN				5							5
TOTAL MATERIAL				21							21
TOTAL OTHER											
TOTAL COST		12		270		3					285

MLLV
RECURRING
PART I
INSTRUMENTATION - F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.2.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	14,961		
Tooling	919		
Manufacturing Test	695		
Q&RA	4,199		
Facilities	344		
Manufacturing Technician	<u>376</u>		
Total Direct Labor	<u>21,494</u>		
Program Executive		258	3,047
Program Planning & Reporting		645	7,617
Industrial Relations		<u>140</u>	<u>1,361</u>
Total Labor - Part I		<u>1,043</u>	<u>12,025</u>
<u>Material</u>			
Program Planning & Reporting			12
Industrial Relations			<u>14</u>
Material Subtotal			26
Material & Administrative Burden			<u>9</u>
Total Material			<u>35</u>
TOTAL COST - PART I			12,060

TABLE 5.3.2.3-III

MLLV PART II COST SUMMARY

INSTRUMENTATION - F/M

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING					1	9			1	9
PRODUCTION			15	145					15	145
MANUFACTURING TEST							1	7	1	7
MANUFACTURING TECH.				5						5
Q & R A			4	37		2		2	4	41
DIRECT DIST			4	35		3		2	4	40
TRAINING				2						2
TOTAL DIRECT LABOR			23	224	1	14	1	11	25	249
MATERIAL										
LAB. TECHNICIANS										
TOOLING						2				2
PRODUCTION				12						12
MFG. TECHNICIANS				1						1
Q & R A				1						1
SUBTOTAL				14		2				16
MAT. & ADM. BURDEN				4		1				5
TOTAL MATERIAL				18		3				21
TOTAL PART II COST				242		17		11		270

PART II
MANUFACTURING
PRODUCTION

INSTRUMENTATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	10,549	102,536
(2) Miscellaneous Charges	823	7,999
(3) Maintain & Add in Scope Changes	116	1,128
Subtotal (A)	11,488	111,663
(4) Tool & Production Planning	3,473	33,758
Subtotal (B)	14,961	145,421
(5) Direct Distributable	3,676	35,731
Subtotal (C)	18,637	181,152
(6) Training	205	1,992
Subtotal (D)	18,842	183,144
(7) Q&RA	3,768	36,625
(8) Mfg. Tech.	358	4,228
Total Production Labor	<u>22,968</u>	<u>223,997</u>
Material		
(9) Raw Material & Standards		11,817
(10) Q&RA		1,131
(11) Mfg. Tech.		626
Material Subtotal		13,574
(12) Material & Adm. Burden		4,615
Total Material		<u>18,189</u>
Total Production Cost		<u>242,186</u>

MLLV
PART II
MANUFACTURING
TOOLING

INSTRUMENTATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	919	8,932
(2) Direct Distributabel	<u>294</u>	<u>2,858</u>
Subtotal (A)	1,213	11,790
(3) Training	<u>13</u>	<u>127</u>
Subtotal (B)	1,226	11,917
(4) Q&RA	<u>245</u>	<u>2,381</u>
Total Tooling Labor	<u><u>1,471</u></u>	<u><u>14,298</u></u>
Material		
(5) Tooling		1,608
(6) Q&RA		<u>73</u>
Subtotal (C)		1,681
(7) Material & Adm. Burden		<u>571</u>
Total Material		<u><u>2,252</u></u>
Total Tooling Cost		<u><u>16,550</u></u>

PART II
MANUFACTURING
MANUFACTURING TEST

INSTRUMENTATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	527	5,122
Component Test Planning	168	1,633
(1) Subtotal	695	6,755
(2) Direct Distributable	223	2,168
Subtotal	918	8,923
(3) Training	10	97
Subtotal	928	9,020
(4) Mfg. Tech.	18	213
Subtotal	946	9,233
(5) Q&RA	186	1,808
Total Mfg. Test Labor	1,132	11,041
Material		
(6) Q&RA		56
(7) Mfg. Tech.		31
Subtotal		87
(8) Material & Adm. Burden		29
Total Material		116
Total Mfg. Test Cost		11,157

MLLV
PART III
FACILITY LABOR

INSTRUMENTATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	344	3,344
TOTAL FACILITY LABOR COST	<u>344</u>	<u>3,344</u>

5.3.2.4 Flight Control System - Injection Stage Fuel Module

TABLE 5.3.2.4-I

MLLV COST SUMMARY

FLIGHT CONTROL - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE		1									1
PROGRAM PLAN. & REPT.		2									2
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING				2							2
PRODUCTION			4	41						4	41
MANUFACTURING TEST				2							2
MANUFACTURING TECH.			1	1						1	1
Q & R A			1	12						1	12
FACILITIES						1					1
DIRECT DIST			1	12						1	12
TRAINING				1							1
TOTAL DIRECT LABOR		3	7	71		1				7	75
MATERIAL				37							37
LOGISTIC HARDWARE											
BURDEN				12							12
TOTAL MATERIAL				49							49
TOTAL OTHER											
TOTAL COST		3		120		1					124

MLLV

PART I
FLIGHT CONTROL - F/MASSEMBLY OR SYSTEM

TABLE 5.3.2.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	4,249		
Tooling	261		
Manufacturing Test	198		
Q&RA	1,193		
Facilities	98		
Manufacturing Technician	106		
Total Direct Labor	<u>6,105</u>		
Program Executive		74	864
Program Planning & Reporting		183	2,164
Industrial Relations		39	386
Total Labor - Part I		<u>296</u>	<u>3,414</u>
<u>Material</u>			
Program Planning & Reporting			4
Industrial Relations			4
Material Subtotal			<u>8</u>
Material & Administrative Burden			3
Total Material			<u>11</u>
TOTAL COST - PART I			<u>3,425</u>

TABLE 5.3.2.4-III

FLIGHT CONTROL - FUEL MODULE

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING						2				2
PRODUCTION			4	41					4	41
MANUFACTURING TEST								2		2
MANUFACTURING TECH.			1	1					1	1
Q & R A			1	11		1			1	12
DIRECT DIST			1	10		1		1	1	12
TRAINING				1						1
TOTAL DIRECT LABOR			7	64		4		3	7	71
MATERIAL										
LAB. TECHNICIANS										
TOOLING						1				1
PRODUCTION				36						36
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				36		1				37
MAT. & ADM. BURDEN				12						12
TOTAL MATERIAL				48		1				49
TOTAL PART II COST				112		5		3		120

MLLV
PART II
MANUFACTURING
PRODUCTION

FLIGHT CONTROL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	2,996	29,122
(2) Miscellaneous Charges	233	2,271
(3) Maintain & Add in Scope Changes	<u>34</u>	<u>320</u>
Subtotal (A)	3,263	31,713
(4) Tool & Production Planning	<u>987</u>	<u>9,589</u>
Subtotal (B)	4,250	41,302
(5) Direct Distributable	<u>1,044</u>	<u>10,147</u>
Subtotal (C)	5,294	51,449
(6) Training	<u>58</u>	<u>566</u>
Subtotal (D)	5,352	52,015
(7) Q&RA	1,070	10,403
(8) Mfg. Tech.	<u>101</u>	<u>1,202</u>
Total Production Labor	<u>6,523</u>	<u>63,620</u>
Material		
(9) Raw Material & Standards		35,620
(10) Q&RA		321
(11) Mfg. Tech.		<u>178</u>
Material Subtotal		36,119
(12) Material & Adm. Burden		<u>12,280</u>
Total Material		<u>48,399</u>
Total Production Cost		<u>112,019</u>

MLIV
PART II
MANUFACTURING
TOOLING

FLIGHT CONTROL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	261	2,537
(2) Direct Distributabel	<u>83</u>	<u>811</u>
Subtotal (A)	344	3,348
(3) Training	<u>4</u>	<u>37</u>
Subtotal (B)	348	3,385
(4) Q&RA	<u>70</u>	<u>678</u>
Total Tooling Labor	<u>418</u>	<u>4,063</u>
Material		
(5) Tooling		457
(6) Q&RA		<u>21</u>
Subtotal (C)		478
(7) Material & Adm. Burden		<u>162</u>
Total Material		<u>640</u>
Total Tooling Cost		<u>4,703</u>

MLLV
PART III
FACILITY LABOR

FLIGHT CONTROL SYSTEM - F/M

TABLE 5.3.2.4-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	98	952
Total Facility Labor Cost	<u>98</u>	<u>952</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

FLIGHT CONTROL SYSTEM - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.2.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	150	1,458
Component Test Planning	<u>48</u>	<u>467</u>
(1) Subtotal	198	1,925
(2) Direct Distributable	<u>63</u>	<u>615</u>
Subtotal	261	2,540
(3) Training	<u>3</u>	<u>28</u>
Subtotal	264	2,568
(4) Mfg. Tech.	<u>5</u>	<u>59</u>
Subtotal	267	2,627
(5) Q&RA	<u>53</u>	<u>514</u>
Total Mfg. Test Labor	<u><u>322</u></u>	<u><u>3,141</u></u>
Material		
(6) Q&RA		16
(7) Mfg. Tech.		<u>9</u>
Subtotal		25
(8) Material & Adm. Burden		<u>8</u>
Total Material		<u><u>33</u></u>
Total Mfg. Test Cost		<u><u>3,174</u></u>

5.3.3 Injection Stage Liquid Engine

Costs for the 125,000 pound (vacuum) thrust high pressure engines for the injection stage were developed from the parametric cost data supplied by Pratt and Whitney.

ENGINE - FUEL MODULE (MULTICHAMBER)

TABLE 5.3.3.0-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING				150							150
LAB TECHNICIANS											
TOOLING				180							180
PRODUCTION				2,040							2,040
MANUFACTURING TEST				130							130
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST.											
TRAINING											
TOTAL DIRECT LABOR				2,500							2,500
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST				2,500							2,500

MELV

FUEL MODULE
MULTI-CHAMBER
PLUG ENGINE

TABLE 5.3.3.0-II

"C" - COSTS

Engineering	\$.15
Test	.13
Tooling (Maint.)	.18
Fabrication	<u>2.03</u>
Subtotal	2.49 (Rounded to 2.5m)

(1st. Unit \$1.37M X (4) 3.7744 (95%)

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5.3.4 Engine Installation - Injection Stage Fuel Module

Installation costs associated with two high pressure engines were based on manhour estimates which were derived from Saturn V historical data. In addition to the direct factory labor, all supporting costs were included.

TABLE 5.3.4.0-I

ENGINE INSTALLATION - FUEL MODULE

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.		2									2
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING				2							2
PRODUCTION			4	37						4	37
MANUFACTURING TEST				2							2
MANUFACTURING TECH.				1							1
Q & R A			1	10						1	10
FACILITIES						1					1
DIRECT DIST			1	10						1	10
TRAINING				1							1
TOTAL DIRECT LABOR		2	6	63		1				6	66
MATERIAL				1							1
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				1							1
TOTAL OTHER											
TOTAL COST		2		64		1					67

MLLV
NON-RECURRING
PART I
ENGINE INSTALLATION - F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.4.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering			
Logistics			
Laboratory Technician			
Production	3,838		
Tooling	236		
Manufacturing Test	132		
Q&RA	1,064		
Facilities	89		
Manufacturing Technician	96		
Total Direct Labor			
Program Executive		66	421
Program Planning & Reporting		163	1,042
Industrial Relations		36	176
Total Labor - Part I		265	1,639
<u>Material</u>			
Program Planning & Reporting			3
Industrial Relations			3
Material Subtotal			6
Material & Administrative Burden			3
Total Material			9
TOTAL COST - PART I			1,648

TABLE 5.3.4.0-III

ENGINE INSTALLATION - F/M

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING										
LAB TECHNICIANS										
TOOLING						2				2
PRODUCTION			4	37					4	37
MANUFACTURING TEST								2		2
MANUFACTURING TECH.				1						1
Q & R A			1	9		1			1	10
DIRECT DIST			1	9		1			1	10
TRAINING				1						1
TOTAL DIRECT LABOR			6	57		4		2	6	63
MATERIAL										
LAB. TECHNICIANS										
TOOLING				1						1
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL				1						1
MAT. & ADM. BURDEN										
TOTAL MATERIAL				1						1
TOTAL PART II COST				58		4		2		64

MLLV
PART II
MANUFACTURING
PRODUCTION

ENGINE INSTALLATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.4.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	2,706	26,303
(2) Miscellaneous Charges	211	2,051
(3) Maintain & Add in Scope Changes	30	291
Subtotal (A)	2,947	28,645
(4) Tool & Production Planning	891	8,661
Subtotal (B)	3,838	37,306
(5) Direct Distributable	943	9,166
Subtotal (C)	4,781	46,472
(6) Training	52	506
Subtotal (D)	4,833	46,978
(7) Q&RA	966	9,390
(8) Mfg. Tech.	92	1,086
Total Production Labor	<u>5,891</u>	<u>57,454</u>
Material		
(9) Raw Material & Standards		290
(10) Q&RA		161
(11) Mfg. Tech.		
Material Subtotal		451
(12) Material & Adm. Burden		154
Total Material		<u>605</u>
Total Production Cost		<u>58,059</u>

MLIV
PART II
MANUFACTURING
TOOLING

ENGINE INSTALLATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.4.0-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	236	2,294
(2) Direct Distributabel	<u>75</u>	<u>729</u>
Subtotal (A)	311	3,023
(3) Training	<u>4</u>	<u>39</u>
Subtotal (B)	315	3,062
(4) Q&RA	<u>63</u>	<u>613</u>
Total Tooling Labor	<u>378</u>	<u>3,675</u>
Material		
(5) Tooling		413
(6) Q&RA		<u>19</u>
Subtotal (C)		432
(7) Material & Adm. Burden		<u>147</u>
Total Material		<u>579</u>
Total Tooling Cost		<u>4,254</u>

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST

ENGINE INSTALLATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.4.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	100	972
Component Test Planning.	<u>32</u>	<u>311</u>
(1) Subtotal	132	1,283
(2) Direct Distributable	<u>42</u>	<u>410</u>
Subtotal	174	1,693
(3) Training	<u>2</u>	<u>19</u>
Subtotal	176	1,712
(4) Mfg. Tech.	<u>4</u>	<u>39</u>
Subtotal	180	1,751
(5) Q&RA	<u>35</u>	<u>342</u>
Total Mfg. Test Labor	<u>215</u>	<u>2,093</u>
Material		
(6) Q&RA		<u>10</u>
(7) Mfg. Tech.		<u>6</u>
Subtotal		16
(8) Material & Adm. Burden		<u>5</u>
Total Material		<u>21</u>
Total Mfg. Test Cost		<u>2,174</u>

MLLV
PART III
FACILITY LABOR
ENGINE INSTALLATION - F/M

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.3.4.0-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	89	865
TOTAL FACILITY LABOR COST		<u>865</u>

5.3.5 Launch Operations - Injection Stage Fuel Module

The launch operations for the fuel module are divided into two parts. The first part represents the costs for the first and second launches (R&D flight test vehicles). The second part represents the costs for operational vehicles (third vehicle and subsequent vehicles). These parts are each divided into three major categories: 1) Launch Control, 2) Launch Pad Operations, and 3) Off Site Support. Figure 5.3.5.0-1 shows the delta costs of these categories and indicates the applicable sub-sections where the costs are shown in detail. The costs reflected in this section are for launching of one fuel module at a two per year rate.

LAUNCH OPERATIONS - FUEL MODULE - 1 R&D FLIGHT VEHICLE

TABLE 5.3.5.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	50								5	50
PROGRAM PLAN.& REPT.	11	122								11	122
INDUSTRIAL RELATIONS	2	24								2	24
ENGINEERING			28	334						28	334
LAB TECHNICIANS											
TOOLING											
PRODUCTION			347	3381						347	3,381
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			66	652						66	652
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	18	196	441	4367						459	4,563
MATERIAL				2							2
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				2							2
TOTAL OTHER											
TOTAL COST		196		4369							4,565

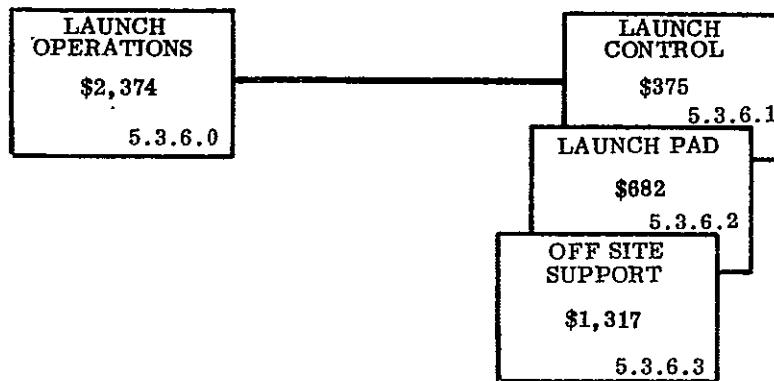
**LAUNCH OPERATIONS - OPERATIONAL VEHICLES (THIRD VEHICLE
AND SUBSEQUENT VEHICLES)**

TABLE 5.3.5.0-II
MLLV COST SUMMARY

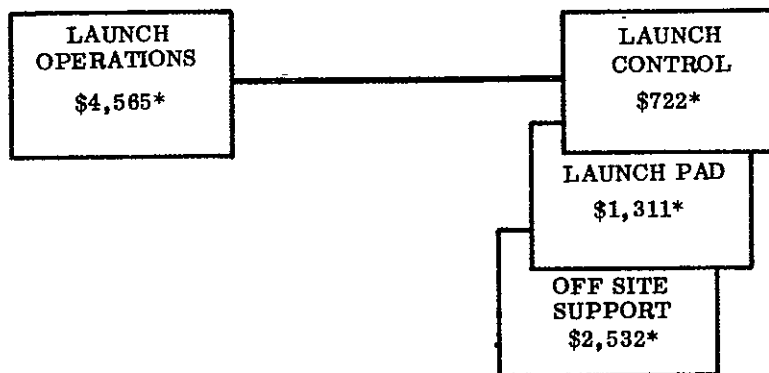
A ☐ B ☐ C ☒ (IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	26								3	26
PROGRAM PLAN.& REPT.	6	63								6	63
INDUSTRIAL RELATIONS	1	12								1	12
ENGINEERING			15	174						15	174
LAB TECHNICIANS											
TOOLING											
PRODUCTION			180	1759						180	1,759
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			34	339						34	339
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	10	101	229	2272						239	2,373
MATERIAL				1							1
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				1							1
TOTAL OTHER											
TOTAL COST		101		2273							2,374

FIXED COST - OPERATIONAL VEHICLE
(THIRD VEHICLE AND SUBSEQUENT VEHICLE)



FIXED COSTS - TWO R&D FLIGHT TEST VEHICLES (INCLUDES ADDITIONAL
COSTS FOR 9 MONTH CYCLE TIME, INCREASED SE&I AND INSTRUMENTATION)



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

*COSTS SHOWN ABOVE ARE INCREASED
BY A FACTOR OF APPROXIMATELY
1.923 FOR THE FLIGHT VEHICLES

FIGURE 5.3.5.0-I FUEL MODULE - LAUNCH OPERATIONS COST FLOW DIAGRAM

5.3.5.1 Launch Control Center .

LAUNCH CONTROL CENTER - FUEL MODULE - 1 R&D FLIGHT VEHICLE

TABLE 5.3.5.1-I.

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	8								1	8
PROGRAM PLAN.& REPT.	2	19								2	19
INDUSTRIAL RELATIONS		4									4
ENGINEERING			4	53						4	53
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			55	535						55	535
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			10	103						10	103
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	3	31	69	691						72	722
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST		31		691							722

MLIV
RECURRING
PART I
LAUNCH CONTROL CENTER ~ F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.5.1-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	4		
Logistics			
Laboratory Technician			
Production	55		
Tooling			
Manufacturing Test			
Q&PA	10		
Facilities			
Manufacturing Technician	—		
Total Direct Labor	<u>69</u>		
Program Executive		1	8
Program Planning & Reporting		2	19
Industrial Relations		—	<u>4</u>
Total Labor - Part I		<u>3</u>	<u>31</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>31</u>

LAUNCH CONTROL CENTER - FUEL MODULE

TABLE 5.3.5.1-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	4	53							4	53
LAB. TECHNICIANS										
TOOLING										
PRODUCTION			55	535					55	535
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			10	103					10	103
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	4	53	65	638					69	691
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL										
MAT. & ADM. BURDEN										
TOTAL MATERIAL										
TOTAL PART II COST		53		638						691

MLLV
 RECURRING
 LAUNCH OPERATIONS
LAUNCH CONTROL CENTER - F/M
TABLE 5.3.5.1-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	4	53
TOTAL COST	<u>4</u>	<u>53</u>

MLLV
 RECURRING
 LAUNCH OPERATIONS
LAUNCH CONTROL CENTER - F/M
 TABLE 5.3.5.1-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	30	294
Technical Support	<u>25</u>	<u>241</u>
Subtotal	55	535
Q&RA	<u>10</u>	<u>103</u>
Total Labor	<u>65</u>	<u>638</u>
Material		
Q&RA		
Material and Administrative Burden		
Total Material		
 TOTAL COST		

5.3.5.2 Launch Pad

LAUNCH PAD - FUEL MODULE - 1 R&D FLIGHT VEHICLE

TABLE 5.3.5.2-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	1	14								1	14
PROGRAM PLAN.& REPT.	3	35								3	35
INDUSTRIAL RELATIONS			8	96						8	96
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION			100	971						100	971
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			19	187						19	187
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	5	56	127	1254						132	1,310
MATERIAL				1							1
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				1							1
TOTAL OTHER											
TOTAL COST		56		1255							1,311

MLLV
RECURRING
PART I
LAUNCH PAD - F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.5.2-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	8		
Logistics			
Laboratory Technician			
Production	100		
Tooling			
Manufacturing Test			
Q&RA	19		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>127</u>		
Program Executive.		1	14
Program Planning & Reporting		3	35
Industrial Relations		<u>1</u>	<u>7</u>
Total Labor - Part I		<u>5</u>	<u>56</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			

LAUNCH PAD - FUEL MODULE

TABLE 5.3.5.2-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	8	96							8	96
LAB. TECHNICIANS										
TOOLING										
PRODUCTION			100	971					100	971
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			19	187					19	187
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	8	96	119	1158					127	1,254
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A										
SUBTOTAL										
MAT. & ADM. BURDEN										
TOTAL MATERIAL										
TOTAL PART II COST		96		1159						1,255

MLLV
RECURRING
LAUNCH OPERATIONS
LAUNCH PAD - F/M
TABLE 5.3.5.2-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	8	96
TOTAL COST	<u>8</u>	<u>96</u>

MLLV
 RECURRING
 LAUNCH OPERATIONS
LAUNCH PAD - F/M
 TABLE 5.3.5.2-V

<u>Element of Cost</u>	(In Thousands) <u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	55	534
Technical Support	<u>45</u>	<u>437</u>
Subtotal	100	971
Q&RA	<u>19</u>	<u>187</u>
Total Labor	<u>119</u>	<u>1,158</u>
Material		
Q&RA		1
Material and Administrative Burden		<u> </u>
Total Material		<u>1,159</u>
 TOTAL COST		

5.3.5.3 Off Site Support Complex

OFF SITE SUPPORT COMPLEX - FUEL MODULE - 1 R&D FLIGHT VEHICLE

TABLE 5.3.5.3-1
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	28								3	28
PROGRAM PLAN.& REPT.	6	68								6	68
INDUSTRIAL RELATIONS	1	13								1	13
ENGINEERING			16	185						16	185
LAB TECHNICIANS											
TOOLING											
PRODUCTION			192	1875						192	1,875
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			37	362						37	362
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	10	109	245	2422						255	2,531
MATERIAL				1							1
LOGISTIC HARDWARE											
EURDEN											
TOTAL MATERIAL				1							1
TOTAL OTHER											
TOTAL COST		109		2423							2,532

MLLV
RECURRING
PART I

OFF SITE SUPPORT COMPLEX - F/M
ASSEMBLY OR SYSTEM
TABLE 5.3.5.3-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	16		
Logistics			
Laboratory Technician			
Production	192		
Tooling			
Manufacturing Test			
Q&RA	37		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>245</u>		
Program Executive		3	28
Program Planning & Reporting		6	68
Industrial Relations		<u>1</u>	<u>13</u>
Total Labor - Part I		<u>10</u>	<u>109</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			

OFF SITE SUPPORT COMPLEX - FUEL MODULE

TABLE 5.3.5.3-III
MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	16	185							16	185
LAB TECHNICIANS										
TOOLING										
PRODUCTION			192	1875					192	1,875
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			37	362					37	362
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	16	185	229	2237					245	2,422
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				1						1
SUBTOTAL				1						1
MAT. & ADM. BURDEN										
TOTAL MATERIAL				1						1
TOTAL PART II COST		185		2238						2,423

MLLV
 RECURRING
 LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - F/M
 TABLE 5.3.5.3-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	16	185
TOTAL COST	<u>16</u>	<u>185</u>

MLLV
 RECURRING
 LAUNCH OPERATIONS
OFF SITE SUPPORT COMPLEX - F/M
 TABLE 5.3.5.3-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	106	1,031
Technical Support	<u>86</u>	<u>844</u>
Subtotal	192	1,875
Q&RA	<u>37</u>	<u>362</u>
Total Labor	<u>229</u>	<u>2,237</u>
Material		
Q&RA		1
Material and Administrative Burden		<u> </u>
Total Material		<u>1</u>
TOTAL COST		<u>2,238</u>

5.3.6 Propellant, Pressurants and Gases - Injection Stage Fuel Module

Propellant costs used on the MLLV engine module were estimated for the following types of propellants:

- a. LOX
- b. LH_2
- c. LN_2
- d. GH_e
- e. GH_2

These costs were based on current actual costs for the Saturn V. An appropriate burden was added to account for the support activities required for procurement.

TABLE 5.3.6.0-I
MLLV COST SUMMARY

PROPELLANT - FUEL MODULE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN. & REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAE TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									365		365
TOTAL COST									365		365

MLLV
RECURRING
PROPELLANT - F/M
(IN THOUSANDS)

TABLE 5.3.6.0-II

	<u>Cubic Feet</u>	<u>Pounds</u>	<u>Dollars</u>
LOX		1,488	18
LH ₂		259	132
LN ₂		533	14
GH _e	1,666		104
GH ₂	408		<u>4</u>
Propellant Cost			272
Material & Administrative Burden			<u>93</u>
* Total Cost			<u><u>\$365</u></u>

For one complete Launch Cycle

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5.4 SRM STAGE FIXED COST

Costs associated with the SRM stage were classified into two categories, i.e.: 1) SRM fixed costs and 2) SRM stage quantity sensitive costs due to the various combinations of SRM stages that can be used within the baseline MLLV vehicle family; i.e., 2 to 8 SRM stages per vehicle.

The costs in this category are for those items which are not considered quantity sensitive to the number of SRM stages per vehicle, i.e.:

- a. The delta cost associated with the alternate forward skirt
- b. The launch operations costs
- c. The launch maintenance cost

These costs are additive to 1) the number of SRM stages required per vehicle times the individual SRM stage variable cost plus 2) the cost of the single stage vehicle (and costs of injection stages where applicable).

Table 5.4.0.0-I summarizes the cost of the SRM by part and elements of costs for the first R&D flight vehicles.

Table 5.4.0.0-II displays (for reference) the costs for the first operational vehicle (third unit).

TOTAL SRM (FIXED) -.1 R&D FLIGHT VEHICLE

TABLE 5.4.0.0-I
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	31								3	31
PROGRAM PLAN.& REPT.	7	77								7	77
INDUSTRIAL RELATIONS	1	13								1	13
ENGINEERING			1060	10170			1	6		1,061	10,176
LAB TECHNICIANS			1	7						1	7
TOOLING			9	88						9	88
PRODUCTION			1441	11561						1,441	11,561
MANUFACTURING TEST			7	66						7	66
MANUFACTURING TECH.			3	43						3	43
Q & R A			42	412						42	412
FACILITIES					3	1183				3	1,183
DIRECT DIST			41	400						41	400
TRAINING			2	21						2	21
TOTAL DIRECT LABOR	11	121	2606	22768	3	1183	1	6		2,621	24,078
MATERIAL		3		297							300
LOGISTIC HARDWARE								30			30
BURDEN		1		59				10			70
TOTAL MATERIAL		4		356				40			400
TOTAL OTHER											
TOTAL COST		125		23124		1183		46			24,478

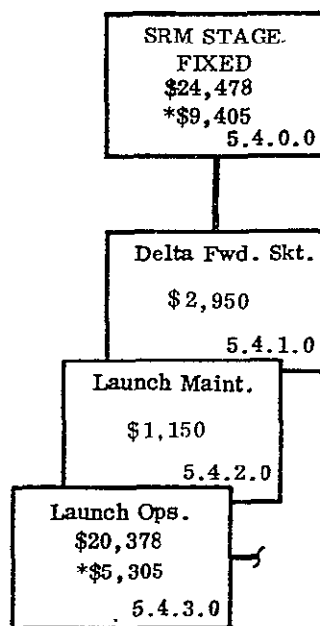
TOTAL SRM (FIXED) - OPERATIONAL VEHICLES
(THIRD VEHICLE AND SUBSEQUENT VEHICLES)

TABLE 5.4.0.0-II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	31								3	31
PROGRAM PLAN.& REPT.	7	77								7	77
INDUSTRIAL RELATIONS	1	13								1	13
ENGINEERING			278	2681			1	6		279	2,687
LAB TECHNICIANS			1	7						1	7
TOOLING			9	88						9	88
PRODUCTION			484	4065						484	4,065
MANUFACTURING TEST			7	66						7	66
MANUFACTURING TECH.			3	43						3	43
Q & R A			42	412						42	412
FACILITIES					3	1183				3	1,183
DIRECT DIST			41	400						41	400
TRAINING			2	21						2	21
TOTAL DIRECT LABOR	11	121	867	7783	3	1183	1	6		882	9,093
MATERIAL		3		209							212
LOGISTIC HARDWARE							30				30
BURDEN		1		59			10				70
TOTAL MATERIAL		4		268			40				312
TOTAL OTHER											
TOTAL COST		125		8051		1183	46				9,405



NOTES:

DOLLARS ARE IN THOUSANDS.
 NUMBERS IN LOWER RIGHT CORNER
 DESIGNATE APPLICABLE SECTION
 NUMBER FOR COST DETAILS.

*FIRST OPERATIONAL UNIT COST WHICH DIFFERS
 SIGNIFICANTLY FROM THOSE OF FIRST R&D FLIGHT
 UNIT

FIGURE 5.4.0.0-1 SRM STAGE - FIXED COST FLOW DIAGRAM

5.4.1 Delta Costs for Forward Skirt (Heavy Weight Skirt)

The costs shown in this section are those associated with the heavy weight forward skirt which are over and above those costs required for the standard (light weight) forward skirt.

TABLE 5.4.1.0-I

MLLV COST SUMMARY

DELTA FORWARD SKIRT

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	31								3	31
PROGRAM PLAN. & REPT.	7	77								7	77
INDUSTRIAL RELATIONS	1	13								1	13
ENGINEERING			3	45			1	6		4	51
LAB TECHNICIANS			1	7						1	7
TOOLING			9	88						9	88
PRODUCTION			147	1,427						147	1,427
MANUFACTURING TEST			7	66						7	66
MANUFACTURING TECH.			3	43						3	43
Q & R A			42	412						42	412
FACILITIES					3	33				3	33
DIRECT DIST			41	400						41	400
TRAINING			2	21						2	21
TOTAL DIRECT LABOR	11	121	255	2,509	3	33	1	6		270	2,669
MATERIAL		3		178							181
LOGISTIC HARDWARE								30			30
BURDEN		1		59				10			70
TOTAL MATERIAL		4		237				40			281
TOTAL OTHER											
TOTAL COST		125		2,746		33		46			2,950

MLLV

PART I
 DELTA FORWARD SKIRT
 ASSEMBLY OR SYSTEM

TABLE 5.4.1.0-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	3,476		
Logistics	524		
Laboratory Technician	695		
Production	146,792		
Tooling	9,017		
Manufacturing Test	6,830		
Q&RA	42,385		
Facilities	3,382		
Manufacturing Technician	<u>3,685</u>		
Total Direct Labor	<u>216,786</u>		
Program Executive		2,602	30,730
Program Planning & Reporting		6,504	76,812
Industrial Relations		<u>1,409</u>	<u>13,696</u>
Total Labor - Part I		<u>10,515</u>	<u>121,238</u>
<u>Material</u>			
Program Planning & Reporting			2,608
Industrial Relations			<u>237</u>
Material Subtotal			2,845
Material & Administrative Burden			<u>968</u>
Total Material			<u>3,813</u>
TOTAL COST - PART I			<u>125,051</u>

TABLE 5.4.1.0-III

MLLV PART II COST SUMMARY DELTA FORWARD SKIRT

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	3	45							3	45
LAB TECHNICIANS	1	7							1	7
TOOLING					9	88			9	88
PRODUCTION			147	1,427					147	1,427
MANUFACTURING TEST							7	66	7	66
MANUFACTURING TECH.			3	41				2	3	43
Q & R A	1	11	37	359	2	24	2	18	42	412
DIRECT DIST			36	351	3	28	2	21	41	400
TRAINING			2	20				1	2	21
TOTAL DIRECT LABOR	5	63	225	2,198	14	140	11	108	255	2,509
MATERIAL										
LAB. TECHNICIANS		1								1
TOOLING						16				16
PRODUCTION				141						141
MFG. TECHNICIANS				6						6
Q & R A		1		11		1		1		14
SUBTOTAL		2		158		17		1		178
MAT. & ADM. BURDEN				53		6				59
TOTAL MATERIAL		2		211		23		1		237
TOTAL PART II COST		65		2,409		163		109		2,746

MLLV
PART II
ENGINEERING
DELTA FORWARD SKIRT
ASSEMBLY OR SYSTEM
TABLE 5.4.1.0-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	<u>3,404</u>	<u>43,758</u>
Reliability Engineering	<u>72</u>	<u>926</u>
(1) Subtotal	<u>3,476</u>	<u>44,684</u>
(2) Laboratory Technicians	<u>695</u>	<u>6,755</u>
Subtotal	<u>4,171</u>	<u>51,439</u>
(3) Q&RA	<u>1,181</u>	<u>11,480</u>
Total Engineering Labor	<u><u>5,352</u></u>	<u><u>62,919</u></u>
Material		
(4) Lab. Tech.		<u>1,459</u>
(5) Q&RA		<u>354</u>
Subtotal		<u>1,813</u>
(6) Material & Adm. Burden		<u>616</u>
Total Material		<u><u>2,429</u></u>
Total Engineering Cost		<u><u>65,348</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION
DELTA FORWARD SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.4.1.0-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	103,498	1,006,001
(2) Miscellaneous Charges	8,073	78,466
(3) Maintain & Add in Scope Changes	1,138	11,061
Subtotal (A)	112,709	1,095,528
(4) Tool & Production Planning	34,083	331,285
Subtotal (B)	146,792	1,426,813
(5) Direct Distributable	36,066	350,565
Subtotal (C)	182,858	1,777,378
(6) Training	2,012	19,554
Subtotal (D)	184,870	1,796,932
(7) Q&RA	36,974	359,385
(8) Mfg. Tech.	3,512	41,479
Total Production Labor	225,356	2,197,796
Material		
(9) Raw Material & Standards		140,621
(10) Q&RA		11,092
(11) Mfg. Tech.		6,147
Material Subtotal		157,860
(12) Material & Adm. Burden		53,672
Total Material		211,532
Total Production Cost		2,409,328

MLIV
PART II
MANUFACTURING
TOOLING

DELTA FORWARD SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.4.1.0-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	9,017	87,646
(2) Direct Distributable	2,885	28,047
Subtotal (A)	11,902	115,693
(3) Training	131	1,272
Subtotal (B)	12,033	116,965
(4) Q&RA	2,407	23,392
Total Tooling Labor	14,440	140,357
Material		
(5) Tooling		15,779
(6) Q&RA		722
Subtotal (C)		16,501
(7) Material & Adm. Burden		5,611
Total Material		22,112
Total Tooling Cost		162,469

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
DELTA FORWARD SKIRT
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.4.1.0-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	5,174	50,292
Component Test Planning	1,656	16,094
(1) Subtotal (A)	<u>6,830</u>	<u>66,386</u>
(2) Direct Distributable	2,186	21,243
Subtotal (B)	<u>9,016</u>	<u>87,629</u>
(3) Training	99	964
Subtotal (C)	<u>9,115</u>	<u>88,593</u>
(4) Mfg. Tech.	173	2,045
Subtotal (D)	<u>9,288</u>	<u>90,638</u>
(5) Q&RA	1,823	17,718
Total Mfg. Test Labor	<u>11,111</u>	<u>108,356</u>
Material		
(6) Q&RA		547
(7) Mfg. Tech.		303
Subtotal (E)		<u>850</u>
(8) Material & Adm. Burden		289
Total Material		<u>1,139</u>
Total Mfg. Test Cost		<u>109,495</u>

MLLV

PART III
FACILITY LABOR

DELTA FORWARD SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.4.1.0-VIII

<u>Element of Cost</u>		<u>Manhours</u>	<u>Dollars</u>
(1)	Direct Labor Hours	<u>3,382</u>	<u>32,874</u>

TOTAL FACILITY LABOR COST

MLLV

PART IV
LOGISTIC LABOR

DELTA FORWARD SKIRT

ASSEMBLY OR SYSTEM

TABLE 5.4.1.0-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	524	6,189
(2) Hardware		29,344
(3) Material & Adm. Burden		<u>9,977</u>
Total Material		<u>39,321</u>
Total Logistic Cost		<u>45,510</u>

5.4.2 Launch Maintenance Cost - SRM Stage

TABLE 5.4.2.0-I
MLLV COST SUMMARY

LAUNCH FACILITY MAINTENANCE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES						1,150					1,150
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR						1,150					1,150
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST						1,150					1,150

MLLV
RECURRING
SRM
*LAUNCH FACILITY MAINTENANCE

5.4.2.-II

(IN THOUSANDS)

TABLE 5.4.2.0-II

Brick and Mortar	\$ 920
Equipment	<u>230</u>
Total	<u><u>\$1,150</u></u>

*Maintenance for six (6) months or for one (1) vehicle.

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5.4.3 Launch Operations Cost - SRM Stage

SRM LAUNCH OPERATIONS - 1 R&D FLIGHT VEHICLES

TABLE 5.4.3.0-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	19	224								19	224
PROGRAM PLAN. & REPT.	46	551								46	551
INDUSTRIAL RELATIONS	11	102								11	102
ENGINEERING			126	1487						126	1,487
LAB TECHNICIANS											
TOOLING											
PRODUCTION			1551	15090						1,552	15,090
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			300	2914						300	2,914
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	17	877	1978	19491						2,054	20,368
MATERIAL				9							9
LOGISTIC HARDWARE											
BURDEN				1							1
TOTAL MATERIAL				10							10
TOTAL OTHER											
TOTAL COST		877		19501							20,378

SRM LAUNCH OPERATIONS - OPERATIONAL VEHICLES (THIRD VEHICLE AND
SUBSEQUENT VEHICLES)

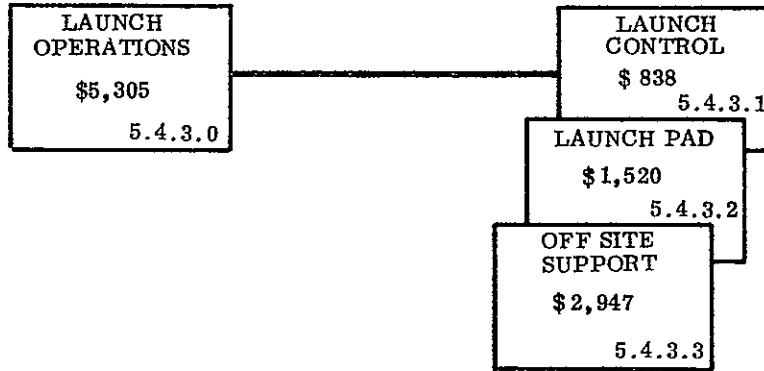
TABLE 5.4.3.0-II
MLLV COST SUMMARY

A ☐ B ☐ C ☒

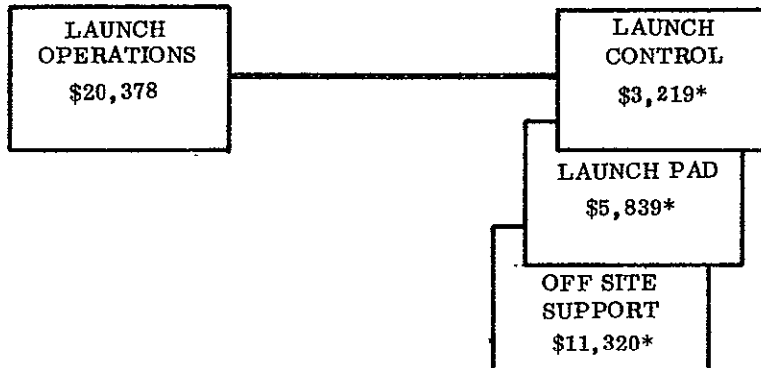
(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	58								5	58
PROGRAM PLAN.& REPT.	12	143								12	143
INDUSTRIAL RELATIONS	3	27								3	27
ENGINEERING			33	387						33	387
LAB TECHNICIANS											
TOOLING											
PRODUCTION			404	3929						404	3,929
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			78	759						78	759
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	20	228	515	5075						535	5,303
MATERIAL				2							2
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				2							2
TOTAL OTHER											
TOTAL COST		228		5077							5,305

FIXED COSTS - OPERATIONAL VEHICLES (THIRD)
VEHICLE AND SUBSEQUENT VEHICLES



FIXED COSTS - TWO R&D FLIGHT TEST VEHICLES (INCLUDES ADDITIONAL
COSTS FOR 9 MONTH CYCLE TIME INCREASED SE&I AND INSTRUMENTATION)



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.
*COSTS SHOWN ABOVE ARE INCREASED
BY A FACTOR OF APPROXIMATELY 3.84 FOR
THE FIRST FLIGHT TEST VEHICLE

FIGURE 5.4.3.0-1 SRM STAGE LAUNCH OPERATIONS COST FLOW DIAGRAM

5.4.3.1 Launch Control - SRM Stage

SRM LAUNCH CONTROL CENTER - 1 R&D FLIGHT VEHICLES

TABLE 5.4.3.1-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	3	35								3	35
PROGRAM PLAN. & REPT.	7	87								7	87
INDUSTRIAL RELATIONS	2	16								2	16
ENGINEERING			20	235						20	235
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			245	2384						245	2,384
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			47	460						47	460
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	12	138	312	3079						324	3,217
MATERIAL				2							2
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				2							2
TOTAL OTHER											
TOTAL COST		138		3081							3219

MLLV
RECURRING
PART I
SRM LAUNCH CONTROL CENTER
ASSEMBLY OR SYSTEM
TABLE 5.4.3.1-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	20		
Logistics			
Laboratory Technician			
Production	245		
Tooling			
Manufacturing Test			
Q&RA	47		
Facilities			
Manufacturing Technician	—		
Total Direct Labor	<u>312</u>		
Program Executive		3	35
Program Planning & Reporting		7	87
Industrial Relations		<u>2</u>	<u>16</u>
Total Labor - Part I		<u>12</u>	<u>138</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
 TOTAL COST - PART I			

SRM LAUNCH CONTROL CENTER

TABLE 5.4.3.1-III
MLLV PART II COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	20	235							20	235
LAB TECHNICIANS										
TOOLING										
PRODUCTION			245	2384					245	2,384
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			47	460					47	460
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	20	235	292	2844					312	3,079
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				2						2
SUBTOTAL				2						2
MAT. & ADM. BURDEN										
TOTAL MATERIAL				2						2
TOTAL PART II COST		235		2846						3,081

MLLV
 RECURRING
 LAUNCH OPERATIONS
SRM LAUNCH CONTROL CENTER
TABLE 5.4.3.1-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	20	235
TOTAL COST	<u>20</u>	<u>235</u>

MLLV
 RECURRING
 LAUNCH OPERATIONS
SRM LAUNCH CONTROL CENTER
TABLE 5.4.3.1-V

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	135	1,311
Technical Support	<u>110</u>	<u>1,073</u>
Subtotal	245	2,384
Q&RA	<u>47</u>	<u>460</u>
Total Labor	<u>292</u>	<u>2,844</u>
Material		
Q&RA		2
Material and Administrative Burden		<u> </u>
Total Material		<u>2</u>
 TOTAL COST		 <u>2,846</u>

5.4.3.2 Launch Pad Cost - SRM Stage

SRM LAUNCH PAD - 1 R&D FLIGHT VEHICLES

TABLE 5.4.3.2-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	5	64								5	64
PROGRAM PLAN. & REPT.	13	158								13	158
INDUSTRIAL RELATIONS	3	29								3	29
ENGINEERING			36	426						36	426
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			445	4324						445	4,324
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			86	835						86	835
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR	21	251	567	5585						588	5,836
MATERIAL				3							3
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				3							3
TOTAL OTHER											
TOTAL COST		251		5588							5,839

MLLV
RECURRING
PART I
SRM LAUNCH PAD
TABLE 5.4.3.2-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	36		
Logistics			
Laboratory Technician			
Production	445		
Tooling			
Manufacturing Test			
Q&RA	86		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>567</u>		
Program Executive		5	64
Program Planning & Reporting		13	158
Industrial Relations		<u>3</u>	<u>29</u>
Total Labor - Part I		<u>21</u>	<u>251</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			
TOTAL COST - PART I			<u>251</u>

SRM LAUNCH PAD

TABLE 5.4.3.2-III

MLLV PART II COST SUMMARY

A ☐ B ☐ C ☒

IN THOUSANDS

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	36	426							36	426
LAB TECHNICIANS										
TOOLING										
PRODUCTION			445	4324					445	4,324
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			86	835					86	835
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	36	426	531	5159					567	5,585
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				3						3
SUBTOTAL				3						3
MAT. & ADM. BURDEN										
TOTAL MATERIAL				3						3
TOTAL PART II COST		426		5162						5,588

MLLV
 RECURRING
 LAUNCH OPERATIONS
 SRM LAUNCH PAD
 TABLE 5.4.3.2-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	36	426
TOTAL COST	<u>36</u>	<u>426</u>

MLLV
RECURRING
LAUNCH OPERATIONS
SRM LAUNCH PAD
TABLE 5.4.3.2-v

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	245	2,378
Technical Support	<u>200</u>	<u>1,946</u>
Subtotal	445	4,324
Q&RA	<u>86</u>	<u>835</u>
Total Labor	<u>531</u>	<u>5,159</u>
Material		
Q&RA		3
Material and Administrative Burden		<u> </u>
Total Material		<u>3</u>
TOTAL COST		<u>5,162</u>

5.4.3.3 Off Site Support - SRM Stage

SRM OFF SITE SUPPORT COMPLEX - 1 R&D FLIGHT VEHICLES

TABLE 5.4.3.3-I
MLLV COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE	11	125								11	125
PROGRAM PLAN.& REPT.	26	306								26	306
INDUSTRIAL RELATIONS	6	57								6	57
ENGINEERING			70	826						70	826
LAB TECHNICIANS											
TOOLING											
PRODUCTION OR OPER			862	8382						862	8,382
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A			167	1619						167	1,619
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABCR	43	488	1099	10827						1,142	11,315
MATERIAL				4							4
LOGISTIC HARDWARE											
BURDEN				1							1
TOTAL MATERIAL				5							5
TOTAL OTHER											
TOTAL COST		488		10832							11,320

MLLV
RECURRING
PART I
SRM OFF SITE SUPPORT COMPLEX
ASSEMBLY OR SYSTEM
TABLE 5.4.3.3-II

<u>Element of Cost</u>	<u>Manhours</u>	(In Thousands)	
		<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	70		
Logistics			
Laboratory Technician			
Production	862		
Tooling			
Manufacturing Test			
Q&RA	167		
Facilities			
Manufacturing Technician			
Total Direct Labor	<u>1,099</u>		
Program Executive		11	125
Program Planning & Reporting		26	306
Industrial Relations		<u>6</u>	<u>57</u>
Total Labor - Part I		<u>43</u>	<u>488</u>
<u>Material</u>			
Program Planning & Reporting			
Industrial Relations			
Material Subtotal			
Material & Administrative Burden			
Total Material			<u>488</u>
TOTAL COST - PART I			

SRM OFF SITE SUPPORT COMPLEX

TABLE 5.4.3.3-III
MLLV PART II COST SUMMARYA ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
ENGINEERING	70	826							70	826
LAB. TECHNICIANS										
TOOLING										
PRODUCTION			862	8382					862	8,382
MANUFACTURING TEST										
MANUFACTURING TECH.										
Q & R A			167	1,619					167	1,619
DIRECT DIST										
TRAINING										
TOTAL DIRECT LABOR	70	826	1029	10001					1,099	10,827
MATERIAL										
LAB. TECHNICIANS										
TOOLING										
PRODUCTION										
MFG. TECHNICIANS										
Q & R A				4						4
SUBTOTAL				4						4
MAT. & ADM. BURDEN				1						1
TOTAL MATERIAL				5						5
TOTAL PART II COST		826		10006						10,832

MLLV
 RECURRING
 LAUNCH OPERATIONS
SRM OFF SITE SUPPORT COMPLEX
TABLE 5.4.3.3-IV

<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Engineering:		
Design Support	70	826
TOTAL COST	<u>70</u>	<u>826</u>

MLLV
RECURRING
LAUNCH OPERATIONS
SRM OFF SITE SUPPORT COMPLEX
TABLE 5.4.3.3-V

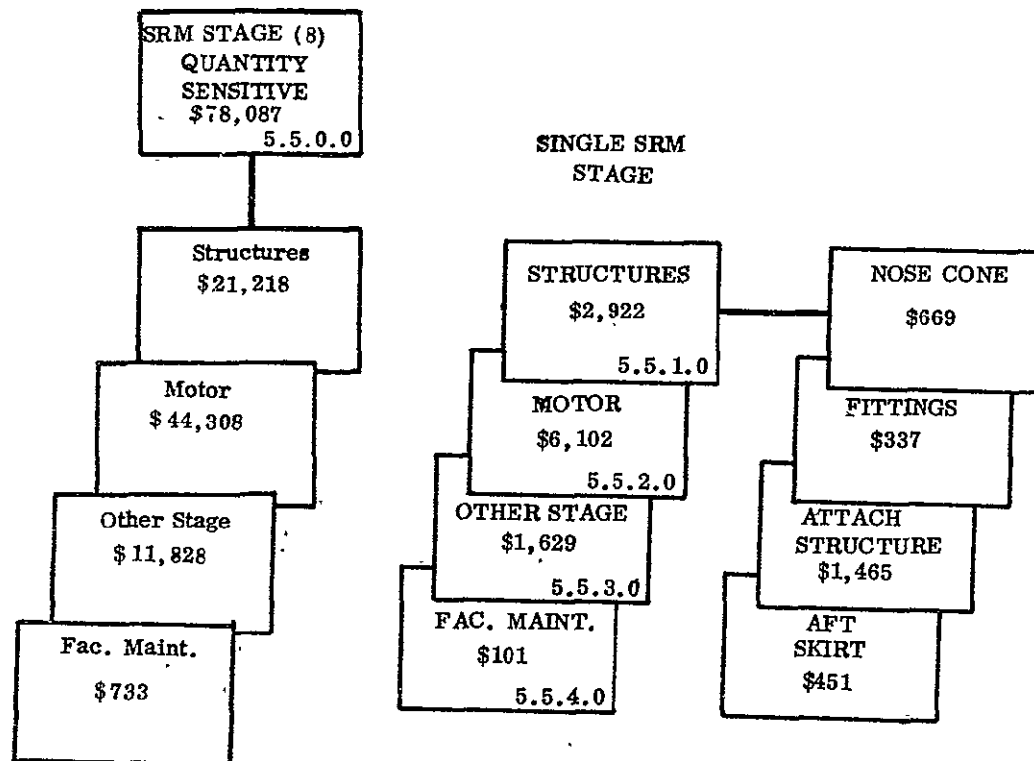
<u>Element of Cost</u>	(In Thousands)	
	<u>Manhours</u>	<u>Dollars</u>
Operations:		
Launch Vehicle	474	4,610
Technical Support	<u>388</u>	<u>3,772</u>
Subtotal	862	8,382
Q&RA	<u>167</u>	<u>1,619</u>
Total Labor	<u>1,029</u>	<u>10,001</u>
Material		
Q&RA		4
Material and Administrative Burden		<u>1</u>
Total Material		<u>5</u>
TOTAL COST		<u>10,006</u>

5.5 SRM STAGE QUANTITY SENSITIVE COST

The cost details for the first unit 260 inch SRM are reflected in Sections 5.5.1 through 5.5.4. Table 5.5.0.0-I displays the total cost associated with units one through eight.

The SRM motor costs were supplied by Aerojet-General Corporation, these costs were supplemented by the costs for the other stage hardware and cost for maintenance of the applicable portion manufacturing facility at Michoud.

FULL COMPLIMENT
OF SRM STAGES



NOTES:

DOLLARS ARE IN THOUSANDS.
NUMBERS IN LOWER RIGHT CORNER
DESIGNATE APPLICABLE SECTION
NUMBER FOR COST DETAILS.

FIGURE 5.5.0.0-1 SRM STAGE QUANTITY SENSITIVE COST FLOW DIAGRAM

TABLE 5.5.0.0-I

MLLV COST SUMMARY

SOLID ROCKET MOTOR STAGES

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL											
TOTAL OTHER									78,087		78,087
TOTAL COST									78,087		78,087

MLLV
SOLID ROCKET MOTOR STAGE

(DOLLARS IN THOUSANDS)

TABLE 5.5.0.0-II

<u>Item</u>	<u>First Unit Cost</u>		<u>*Curve (8)</u>		<u>Dollars</u>
Structure	2,922	x	2.2612	=	21,218
Motor	6,102	x	"	=	44,308
Other Stage Hardware	1,629	x	"	=	11,828
Mfg. Facilities Maint.	101	x	"	=	<u>733</u>
TOTAL	<u>10,754</u>				<u>78,087</u>

*95% Composite

5.5.1 Structures for SRM

TABLE 5.5.1.0-I

MLL/ COST SUMMARY

TOTAL SRM STRUCTURE

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive	3	\$ 28								3	28
Program Plan. & Rept.	6	71								6	71
Industrial Relations	1	14								1	14
Engineering			17	215			4	33		21	248
Laboratory Technicians			4	35						4	35
Tooling			8	74						8	74
Production			123	1,203						123	1,203
Manufacturing Test			5	45						5	45
Manufacturing Tech.			3	35						3	35
Q&RA			33	343						33	343
Facilities					3	28				3	28
Direct Distributable			35	334						35	334
Training			2	18						2	18
Total Direct Labor	10	\$ 113	230	\$2,302	3	\$ 28	4	\$ 33		247	\$2,476
Material				263							263
Logistic Hardware								70			70
Burden				90				23			113
Total Material				\$ 353				\$ 93			\$ 446
Total Other											
TOTAL COST		\$ 113		\$2,655		\$ 28		\$ 126			\$2,922

TABLE 5.5.1.1-I
MLLV COST SUMMARY

SRM NOSE CONE
ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒ X

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive	1	7								1	\$ 7
Program Plan. & Rept.	1	16								1	16
Industrial Relations		3									3
Engineering			4	51			1	8		5	59
Laboratory Technicians			1	8						1	8
Tooling			2	17						2	17
Production			28	276						28	276
Manufacturing Test			1	9						1	9
Manufacturing Tech.			1	8						1	8
Q&RA			7	79						7	79
Facilities					1	6				1	6
Direct Distributable			8	76						8	76
Training			1	4						1	4
Total Direct Labor	2	\$ 26	53	\$ 528	1	\$ 6	1	\$ 8		57	\$ 568
Material				59							59
Logistic Hardware								17			17
Burden				20				5			25
Total Material				\$ 79				\$ 22			\$ 101
Total Other											
TOTAL COST		\$ 26		\$ 607		\$ 6		\$ 30			\$ 669

MLLV
 RECURRING
 PART I
 SRM
 NOSE CONE
 ASSEMBLY OR SYSTEM
 TABLE 5.5.1.1-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	4,340		
Logistics	660		
Laboratory Technician	868		
Production	28,366		
Tooling	1,742		
Manufacturing Test	950		
Q&RA	8,042		
Facilities	653		
Manufacturing Technician	703		
Total Direct Labor	<u>46,324</u>		
Program Executive		556	6,566
Program Planning & Reporting		1,390	16,416
Industrial Relations		301	2,926
Total Labor - Part I		<u>2,247</u>	<u>25,908</u>
<u>Material</u>			
Program Planning & Reporting			28
Industrial Relations			30
Material Subtotal			58
Material & Administrative Burden			20
Total Material			<u>78</u>
TOTAL COST - PART I			<u>25,986</u>

TABLE 5.5.1.1-III

MLLV-SRM NOSE CONE

MLLV PART II COST SUMMARY

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
Engineering	4	\$ 51							4	\$ 51
Lab Technicians	1	8							1	8
Tooling					2	17			2	17
Production			28	276					28	276
Manufacturing Test							1	9	1	9
Manufacturing Tech.			1	8					1	8
Quality & Reliability Assurance		2	7	69		5		3	7	79
Direct Distributable Training			7	68	1	5		3	8	76
			1	4					1	4
Total Direct Labor	5	\$ 61	44	\$ 425	3	\$ 27	1	\$ 15	53	\$ 528
Material										
Lab. Technicians		2								2
Tooling						3				3
Production				51						51
Mfg. Technicians				1						1
Quality & Reliability Assurance				2						2
Subtotal		2		54		3				59
Material & Administrative Burden		1		18		1				20
Total Material		\$ 3		\$ 72		\$ 4				\$ 79
TOTAL PART II COST		\$ 64		\$ 497		\$ 31		\$ 15		\$ 607

PART II
ENGINEERING
MLLV-NOSE CONE
ASSEMBLY OR SYSTEM
TABLE 5.5.1.1-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	4,250	\$ 50,193
Reliability Engineering	<u>90</u>	<u>1,063</u>
(1) Subtotal	4,340	51,256
(2) Laboratory Technicians	<u>868</u>	<u>8,437</u>
Subtotal	5,208	59,693
(3) Q&RA	<u>174</u>	<u>1,691</u>
Total Engineering Labor	<u><u>5,382</u></u>	<u><u>61,384</u></u>
Material		
(4) Lab. Tech.		1,823
(5) Q&RA		<u>52</u>
Subtotal		1,875
(6) Material & Adm. Burden		<u>638</u>
Total Material		<u><u>2,513</u></u>
Total Engineering Cost		\$ <u><u>63,897</u></u>

PART II
MANUFACTURING
PRODUCTION
SRM
MLLV-NOSE CONE
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.1-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	20,000	\$ 194,400
(2) Miscellaneous Charges	1,560	15,163
(3) Maintain & Add in Scope Changes	220	2,138
Subtotal	21,780	211,701
(4) Tool & Production Planning	6,586	64,016
Subtotal	28,366	275,717
(5) Direct Distributable	6,970	67,748
Subtotal	35,336	343,465
(6) Training	389	3,781
Subtotal	35,725	347,246
(7) Q&RA	7,145	69,449
(8) Mfg. Tech.	679	8,019
Total Production Labor	43,549	\$ 424,714
Material		
(9) Raw Material & Standards		50,650
(10) Q&RA		2,144
(11) Mfg. Tech.		1,188
Material Subtotal		53,982
(12) Material & Adm. Burden		18,354
Total Material		\$ 72,336
Total Production Cost		\$ 497,050

PART II
MANUFACTURING
TOOLING
SRM
MLLV-NOSE CONE

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.1-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>1,742</u>	<u>\$ 16,932</u>
(2) Direct Distributable	<u>557</u>	<u>5,414</u>
Subtotal	<u>2,299</u>	<u>22,346</u>
(3) Training	<u>25</u>	<u>243</u>
Subtotal	<u>2,324</u>	<u>22,589</u>
(4) Q&RA	<u>465</u>	<u>4,520</u>
Total Tooling Labor	<u><u>2,789</u></u>	<u><u>\$ 27,109</u></u>
Material		
(5) Tooling		<u>3,049</u>
(6) Q&RA		<u>140</u>
Subtotal		<u>3,189</u>
(7) Material & Adm. Burden		<u>1,084</u>
Total Material		<u><u>\$ 4,273</u></u>
Total Tooling Cost		<u><u>\$ 31,382</u></u>

PART II
MANUFACTURING
MANUFACTURING TEST
SRM
MLLV-NOSE CONE

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.1-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	646	\$ 6,279
Component Test Planning	304	2,955
(1) Subtotal	950	9,234
(2) Direct Distributable	304	2,955
Subtotal	1,254	12,189
(3) Training	14	136
Subtotal	1,268	12,325
(4) Mfg. Tech.	24	283
Subtotal	1,292	12,608
(5) Q&RA	258	2,508
Total Mfg. Test Labor	<u>1,550</u>	\$ <u>15,116</u>
Material		
(6) Q&RA		77
(7) Mfg. Tech.		42
Subtotal		119
(8) Material & Adm. Burden		40
Total Material		\$ <u>159</u>
Total Mfg. Test Cost		\$ <u>15,275</u>

PART III
FACILITY LABOR
SRM
MLLV-NOSE CONE
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.1-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	653	6,347
TOTAL FACILITY LABOR COST	<u> </u>	<u>\$6,347</u>

PART IV
LOGISTIC LABOR
SRM
MLLV-NOSE CONE
ASSEMBLY OR SYSTEM
TABLE 5.5.1.1-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>660</u>	<u>7,795</u>
(2) Hardware	<u> </u>	<u>16,500</u>
(3) Material & Adm. Burden	<u> </u>	<u>5,610</u>
Total Material	<u> </u>	<u>22,110</u>
Total Logistic Cost	<u> </u>	<u>29,905</u>

TABLE 5.5.1.2-I
MLL/ COST SUMMARY

SRM FITTINGS
ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive		\$ 3									\$ 3
Program Plan. & Rept.	1	8								1	8
Industrial Relations		2									2
Engineering			4	51			1	8		5	59
Laboratory Technicians			1	8						1	8
Tooling			1	7						1	7
Production			11	110						11	110
Manufacturing Test			1	9						1	9
Manufacturing Tech.				3							3
Q&RA			3	35						3	35
Facilities						3					3
Direct Distributable			3	32						3	32
Training				2							2
Total Direct Labor	1	\$ 13	24	\$ 257		\$ 3	1	\$ 8		26	\$ 281
Material				25							25
Logistic Hardware								17			17
Burden				9				5			14
Total Material				\$ 34				\$ 22			\$ 56
Total Other											
TOTAL COST		\$ 13		\$ 291		\$ 3		\$ 30			\$ 337

MLLV
RECURRING
PART I
SRM - FITTINGS
ASSEMBLY OR SYSTEM

TABLE 5.5.1.2-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	4,340		
Logistics	660		
Laboratory Technician	868		
Production	11,347		
Tooling	697		
Manufacturing Test	950		
Q&RA	3,476		
Facilities	261		
Manufacturing Technician	296		
Total Direct Labor	22,895		
Program Executive		275	3,248
Program Planning & Reporting		687	8,113
Industrial Relations		149	1,448
Total Labor - Part I		1,111	12,809
<u>Material</u>			
Program Planning & Reporting			14
Industrial Relations			15
Material Subtotal			29
Material & Administrative Burden			10
Total Material			39
TOTAL COST - PART I			12,848

TABLE 5.5.1.2-III

MLLV-SRM FITTINGS

MLLV PART II COST SUMMARY

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
Engineering.	4	\$ 51							4	\$ 51
Lab Technicians	1	8							1	8
Tooling					1	7			1	7
Production			11	110					11	110
Manufacturing Test							1	9	1	9
Manufacturing Tech.				3						3
Quality & Reliability Assurance		2	3	28		2		3	3	35
Direct Distributable Training			3	27		2		3	3	32
				2						2
Total Direct Labor	5	61	17	170	1	11	1	15	24	257
Material										
Lab. Technicians		2								2
Tooling						1				1
Production				21						21
Mfg. Technicians										
Quality & Reliability Assurance				1						1
Subtotal		2		22		1				25
Material & Administrative Burden		1		8						9
Total Material		\$ 3		\$ 30		1				\$ 34
TOTAL PART II COST		\$ 64		\$ 200		\$ 12		\$ 15		\$ 291

MLLV
PART II
ENGINEERING
SRM
MLLV - FITTINGS
ASSEMBLY OR SYSTEM

TABLE 5.5.1.2-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	4,250	50,193
Reliability Engineering	<u>90</u>	<u>1,063</u>
(1) Subtotal	4,340	51,256
(2) Laboratory Technicians	<u>868</u>	<u>8,437</u>
Subtotal	5,208	59,693
(3) Q&RA	<u>174</u>	<u>1,691</u>
Total Engineering Labor	<u><u>5,382</u></u>	<u><u>61,384</u></u>
Material		
(4) Lab. Tech.		1,823
(5) Q&RA		<u>52</u>
Subtotal		1,875
(6) Material & Adm. Burden		<u>638</u>
Total Material		<u><u>2,513</u></u>
Total Engineering Cost		<u><u>63,897</u></u>

MLLV
PART II
MANUFACTURING
PRODUCTION
SRM
MLLV - FITTINGS
ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.2-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	8,000	77,760
(2) Miscellaneous Charges	624	6,065
(3) Maintain & Add in Scope Changes	88	855
Subtotal	8,712	84,680
(4) Tool & Production Planning	2,635	25,612
Subtotal	11,347	110,292
(5) Direct Distributable	2,788	27,099
Subtotal	14,135	137,391
(6) Training	155	1,507
Subtotal	14,290	138,898
(7) Q&RA	2,858	27,780
(8) Mfg. Tech.	272	3,212
Total Production Labor	17,420	169,890
Material		
(9) Raw Material & Standards		20,908
(10) Q&RA		857
(11) Mfg. Tech.		476
Material Subtotal		22,241
(12) Material & Adm. Burden		7,562
Total Material		29,803
Total Production Cost		199,693

MLLV
PART II
MANUFACTURING
TOOLING
SRM
MLLV - FITTINGS

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.2-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	697	6,775
(2) Direct Distributable	223	2,168
Subtotal	920	8,943
(3) Training	10	97
Subtotal	930	9,040
(4) Q&RA	186	1,808
Total Tooling Labor	1,116	10,848
Material		
(5) Tooling		1,220
(6) Q&RA		56
Subtotal		1,276
(7) Material & Adm. Burden		434
Total Material		1,710
Total Tooling Cost		12,558

MLLV
PART II
MANUFACTURING
MANUFACTURING TEST
SRM
MLLV - FITTINGS

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.2-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	<u>646</u>	<u>6,279</u>
Component Test Planning	<u>304</u>	<u>2,955</u>
(1) Subtotal	950	9,234
(2) Direct Distributable	<u>304</u>	<u>2,955</u>
Subtotal	1,254	12,189
(3) Training	<u>14</u>	<u>136</u>
Subtotal	1,268	12,325
(4) Mfg. Tech.	<u>24</u>	<u>283</u>
Subtotal	1,292	12,608
(5) Q&RA	<u>258</u>	<u>2,508</u>
Total Mfg. Test Labor	<u>1,550</u>	<u>15,116</u>
Material		
(6) Q&RA		<u>77</u>
(7) Mfg. Tech.		<u>42</u>
Subtotal		119
(8) Material & Adm. Burden		<u>40</u>
Total Material		<u>159</u>
Total Mfg. Test Cost		<u>15,275</u>

MLLV
 PART III
 FACILITY LABOR
 SRM
 MLLV - FITTINGS

ASSEMBLY OR SYSTEM
 1ST UNIT COST

TABLE 5.5.1.2-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	261	2,537
TOTAL FACILITY LABOR COST	<u>261</u>	<u>2,537</u>

MLLV
 PART IV
 LOGISTIC LABOR
 SRM
 FITTINGS
 ASSEMBLY OR SYSTEM

TABLE 5.5.1.2-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>660</u>	<u>7,795</u>
(2) Hardware	<u> </u>	<u>16,500</u>
(3) Material & Adm. Burden	<u> </u>	<u>5,610</u>
Total Material	<u> </u>	<u>22,110</u>
Total Logistic Cost	<u> </u>	<u>29,905</u>

TABLE 5.5.1.3-I
MLLV COST SUMMARY

SRM ATTACH STRUCTURE
ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive	1	\$ 14								1	\$ 14
Program Plan. & Rept.	3	36								3	36
Industrial Relations	1	7								1	7
Engineering			6	72			1	11		7	83
Laboratory Technicians			1	12						1	12
Tooling			4	39						4	39
Production			66	640						66	640
Manufacturing Test			2	18						2	18
Manufacturing Tech.			2	19						2	19
Q&RA			18	178						18	178
Facilities					2	15				2	15
Direct Distributable			18	176						18	176
Training			1	10						1	10
Total Direct Labor	5	\$ 57	118	\$1,164	2	\$ 15	1	\$ 11		126	\$1,247
Material				139							139
Logistic Hardware								23			23
Burden				48				8			56
Total Material				\$ 187				\$ 31			\$ 218
Total Other											
TOTAL COST		\$ 57		\$1,351		\$ 15		\$ 42			\$1,465

MLLV

PART I

SFM ATTACH STRUCTURE
ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.3-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	6,083		
Logistics	917		
Laboratory Technician	1,217		
Production	65,809		
Tooling	4,042		
Manufacturing Test	1,900		
Q&RA	18,415		
Facilities	1,516		
Manufacturing Technician	<u>1,623</u>		
Total Direct Labor	<u>101,522</u>		
Program Executive		1,218	14,385
Program Planning & Reporting		3,046	35,973
Industrial Relations		<u>660</u>	<u>6,415</u>
Total Labor - Part I		<u>4,924</u>	<u>56,773</u>
<u>Material</u>			
Program Planning & Reporting			61
Industrial Relations			66
Material Subtotal			127
Material & Administrative Burden			<u>43</u>
Total Material			<u>170</u>
TOTAL COST - PART I			<u>56,943</u>

TABLE 5.5.1.3-III
MLLV PART II COST SUMMARY

MLLV-SRM ATTACH STRUCTURE

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
Engineering.	6	\$ 72							6	\$ 72
Lab Technicians	1	12							1	12
Tooling					4	39			4	39
Production			66	640					66	640
Manufacturing Test							2	18	2	18
Manufacturing Tech.			2	18				1	2	19
Quality & Reliability Assurance		2	17	161	1	10		5	18	178
Direct Distributable			16	157	1	13	1	6	18	176
Training			1	9		1			1	10
Total Direct Labor	7	86	102	985	6	63	3	30	118	\$1,164
Material										
Lab. Technicians		3								3
Tooling						7				7
Production				121						121
Mfg. Technicians				3						3
Quality & Reliability Assurance				5						5
Subtotal		3		129		7				139
Material & Administrative Burden		1		44		3				48
Total Material		\$ 4		\$ 173		\$ 10				\$ 187
TOTAL PART II COST		\$ 90		\$1,158		\$ 73		\$ 30		\$1,351

PART II
ENGINEERING
MLLV SRM
ATTACH STRUCTURE
ASSEMBLY OR SYSTEM
TABLE 5.5.1.3-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	<u>5,957</u>	<u>70,352</u>
Reliability Engineering	<u>126</u>	<u>1,488</u>
(1) Subtotal	6,083	71,840
(2) Laboratory Technicians	<u>1,217</u>	<u>11,829</u>
Subtotal	7,300	83,669
(3) Q&RA	<u>243</u>	<u>2,362</u>
Total Engineering Labor	<u><u>7,543</u></u>	<u><u>86,031</u></u>
Material		
(4) Lab. Tech.		<u>2,556</u>
(5) Q&RA		<u>73</u>
Subtotal		2,629
(6) Material & Adm. Burden		<u>894</u>
Total Material		<u><u>3,523</u></u>
Total Engineering Cost		<u><u>89,554</u></u>

PART II
MANUFACTURING
PRODUCTION
SEM
MLLV - ATTACH STRUCTURE

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.3-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	46,400	451,008
(2) Miscellaneous Charges	3,619	35,178
(3) Maintain & Add in Scope Changes	510	4,957
Subtotal	50,529	491,143
(4) Tool & Production Planning	15,280	148,522
Subtotal	65,809	639,665
(5) Direct Distributable	16,169	157,163
Subtotal	81,978	796,828
(6) Training	902	8,767
Subtotal	82,880	805,595
(7) Q&RA	16,516	161,119
(8) Mfg. Tech.	1,575	18,601
Total Production Labor	101,031	985,315
Material		
(9) Raw Material & Standards		121,294
(10) Q&RA		4,973
(11) Mfg. Tech.		2,756
Material Subtotal		129,023
(12) Material & Adm. Burden		43,868
Total Material		172,891
Total Production Cost		1,158,206

PART II
MANUFACTURING
TOOLING
SRM
MLLV - ATTACH STRUCTURE

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.3-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	<u>4,042</u>	<u>39,288</u>
(2) Direct Distributable	<u>1,293</u>	<u>12,568</u>
Subtotal	5,335	51,856
(3) Training	<u>59</u>	<u>573</u>
Subtotal	5,394	52,429
(4) Q&RA	<u>1,079</u>	<u>10,488</u>
Total Tooling Labor	<u><u>6,473</u></u>	<u><u>62,917</u></u>
Material		
(5) Tooling		<u>7,074</u>
(6) Q&RA		<u>324</u>
Subtotal		7,398
(7) Material & Adm. Burden		<u>2,515</u>
Total Material		<u><u>9,913</u></u>
Total Tooling Cost		<u><u>72,830</u></u>

PART II
MANUFACTURING
MANUFACTURING TEST
SRM
MLLV - ATTACH STRUCTURE

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.3-VII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	<u>1,292</u>	<u>12,558</u>
Component Test Planning	<u>608</u>	<u>5,910</u>
(1) Subtotal	1,900	18,468
(2) Direct Distributable	<u>608</u>	<u>5,910</u>
Subtotal	2,508	24,378
(3) Training	<u>28</u>	<u>272</u>
Subtotal	2,536	24,650
(4) Mfg. Tech.	<u>48</u>	<u>567</u>
Subtotal	2,584	25,217
(5) Q&RA	<u>517</u>	<u>5,025</u>
Total Mfg. Test Labor	<u><u>3,101</u></u>	<u><u>30,242</u></u>
Material		
(6) Q&RA		<u>155</u>
(7) Mfg. Tech.		<u>84</u>
Subtotal		239
(8) Material & Adm. Burden		<u>81</u>
Total Material		<u><u>320</u></u>
Total Mfg. Test Cost		<u><u>30,562</u></u>

MLLV
 PART III
 FACILITY LABOR
 SRM
MLLV - ATTACH STRUCTURE
 ASSEMBLY OR SYSTEM
 1ST UNIT COST
 TABLE 5.5.1.3-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	1,516	14,736
TOTAL FACILITY LABOR COST	<u> </u>	<u>14,736</u>

MLLV
PART IV
LOGISTIC LABOR
SRM
ATTACH STRUCTURE
ASSEMBLY OR SYSTEM
TABLE 5.5.1.3-IX

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>917</u>	<u>10,830</u>
(2) Hardware	<u> </u>	<u>22,925</u>
(3) Material & Adm. Burden	<u> </u>	<u>7,795</u>
Total Material	<u> </u>	<u>30,720</u>
Total Logistic Cost	<u> </u>	<u>41,550</u>

TABLE 5.5.1.4-I

MLL/ COST SUMMARY

SRM AFT SKIRT

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive	1	\$ 4								1	\$ 4
Program Plan. & Rept.	1	11								1	11
Industrial Relations		2									2
Engineering			3	41			1	6		4	47
Laboratory Technicians			1	7						1	7
Tooling			1	11						1	11
Production			18	177						18	177
Manufacturing Test			1	9						1	9
Manufacturing Tech.				5							5
Q&RA			5	51						5	51
Facilities						4					4
Direct Distributable			6	50						6	50
Training				2							2
Total Direct Labor	2	\$ 17	35	\$353		\$ 4	1	\$ 6		38	\$ 380
Material				40							40
Logistic Hardware								13			13
Burden				13				5			18
Total Material				\$ 53				\$ 18			\$ 71
Total Other											
TOTAL COST		\$ 17		\$ 406		\$ 4		\$ 24			\$ 451

MLLV

PART I

SRM-AFT SKIRT
ASSEMBLY OR SYSTEM

TABLE 5.5.1.4-II

<u>Element of Cost</u>	<u>Manhours</u>	<u>Manhours</u>	<u>Dollars</u>
<u>Direct Labor</u>			
Engineering	3,476		
Logistics	524		
Laboratory Technician	695		
Production	18,154		
Tooling	1,115		
Manufacturing Test	950		
Q&RA	5,268		
Facilities	418		
Manufacturing Technician	458		
Total Direct Labor	<u>31,058</u>		
Program Executive		373	\$ 4,405
Program Planning & Reporting		932	11,007
Industrial Relations		<u>202</u>	<u>1,963</u>
Total Labor - Part I		<u>1,507</u>	<u>\$17,375</u>
<u>Material</u>			
Program Planning & Reporting			19
Industrial Relations			20
Material Subtotal			39
Material & Administrative Burden			<u>13</u>
Total Material			<u>\$ 52</u>
TOTAL COST - PART I			<u>\$17,427</u>

TABLE 5.5.1.4-III

MLLV-SRM AFT SKIRT

MLLV PART II COST SUMMARY

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	ENGINEERING		PRODUCTION		TOOLING		TEST		TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$	M/H	\$
Engineering.	3	\$ 41							3	\$ 41
Lab Technicians	1	7							1	7
Tooling					1	11			1	11
Production			18	177					18	177
Manufacturing Test							1	9	1	9
Manufacturing Tech.				5						5
Quality & Reliability Assurance		1	5	44		3		3	5	51
Direct Distributable Training			5	44	1	3		3	6	50
				2						2
Total Direct Labor	4	\$ 49	28	272	2	\$ 17	1	\$ 15	35	\$ 353
Material										
Lab. Technicians		2								2
Tooling						2				2
Production				34						34
Mfg. Technicians				1						1
Quality & Reliability Assurance				1						1
Subtotal		2		36		2				40
Material & Administrative Burden				12		1				13
Total Material		\$ 2		\$ 48		\$ 3				\$ 53
TOTAL PART II COST		\$ 51		\$ 320		\$ 20		\$ 15		\$ 406

1202

MLLV
PART II
ENGINEERING
SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
TABLE 5.5.1.4-IV

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Design Development	3,404	\$ 40,201
Reliability Engineering	<u>72</u>	<u>850</u>
(1) Subtotal	3,476	41,051
(2) Laboratory Technicians	<u>695</u>	<u>6,755</u>
Subtotal	4,171	47,806
(3) Q&RA	<u>139</u>	<u>1,351</u>
Total Engineering Labor	<u>4,310</u>	<u>49,157</u>
Material		
(4) Lab. Tech.		1,460
(5) Q&RA		<u>42</u>
Subtotal		1,502
(6) Material & Adm. Burden		<u>511</u>
Total Material		<u>2,013</u>
Total Engineering Cost		\$ <u>51,170</u>

MLLV
PART II
MANUFACTURING
PRODUCTION
SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.4-V

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Fabrication & Assembly	12,800	\$ 124,416
(2) Miscellaneous Charges	998	9,701
(3) Maintain & Add in Scope Changes	<u>141</u>	<u>1,371</u>
Subtotal	13,939	135,488
(4) Tool & Production Planning	<u>4,215</u>	<u>40,970</u>
Subtotal	18,154	176,458
(5) Direct Distributable	<u>4,460</u>	<u>43,351</u>
Subtotal	22,614	219,809
(6) Training	<u>249</u>	<u>2,420</u>
Subtotal	22,863	222,229
(7) Q&RA	4,573	44,450
(8) Mfg. Tech.	<u>434</u>	<u>5,126</u>
Total Production Labor	<u>27,870</u>	\$ <u>271,805</u>
Material		
(9) Raw Material & Standards		33,462
(10) Q&RA		1,372
(11) Mfg. Tech.		<u>760</u>
Material Subtotal		35,594
(12) Material & Adm. Burden		<u>12,102</u>
Total Material		\$ <u>47,696</u>
Total Production Cost		\$ <u>319,501</u>

MLIV
PART II
MANUFACTURING
TOOLING
SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST
TABLE 5.5.1.4-VI

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Sustaining Tooling	1,115	\$ 10,838
(2) Direct Distributable	357	3,470
Subtotal	1,472	14,308
(3) Training	16	156
Subtotal	1,488	14,464
(4) Q&RA	298	2,897
Total Tooling Labor	<u>1,786</u>	\$ <u>17,361</u>
Material		
(5) Tooling		1,951
(6) Q&RA		89
Subtotal		2,040
(7) Material & Adm. Burden		694
Total Material		\$ <u>2,734</u>
Total Tooling Cost		\$ <u>20,095</u>

MLIV
PART II
MANUFACTURING
MANUFACTURING TEST
SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.4-VII

<u>ement of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
Component Test	646	\$ 6,279
Component Test Planning	<u>304</u>	<u>2,955</u>
(1) Subtotal	950	9,234
(2) Direct Distributable	<u>304</u>	<u>2,955</u>
Subtotal	1,254	12,189
(3) Training	<u>14</u>	<u>136</u>
Subtotal	1,268	12,325
(4) Mfg. Tech.	<u>24</u>	<u>283</u>
Subtotal	1,292	12,608
(5) Q&RA	<u>258</u>	<u>2,508</u>
Total Mfg. Test Labor	<u>1,550</u>	\$ <u>15,116</u>
Material		
(6) Q&RA		77
(7) Mfg. Tech.		<u>42</u>
Subtotal		119
(8) Material & Adm. Burden		<u>40</u>
Total Material		\$ <u>159</u>
Total Mfg. Test Cost		\$ <u>15,275</u>

MLIV
PART III
FACILITY LABOR

SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
1ST UNIT COST

TABLE 5.5.1.4-VIII

<u>Element of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Direct Labor Hours	418	4,063
TOTAL FACILITY LABOR COST	<u> </u>	<u>\$4,063</u>

MLLV
PART IV
LOGISTIC LABOR
SRM
AFT SKIRT

ASSEMBLY OR SYSTEM
TABLE 5.5.1.4-IX.

<u>ement of Cost</u>	<u>Manhours</u>	<u>Dollars</u>
(1) Engineering	<u>524</u>	<u>6,188</u>
(2) Hardware	<u> </u>	<u>13,100</u>
(3) Material & Adm. Burden	<u> </u>	<u>4,454</u>
Total Material	<u> </u>	<u>17,554</u>
Total Logistic Cost	<u> </u>	<u>23,742</u>

5.5.2 Solid Motor

TABLE 5.5.2.0-I

*SOLID ROCKET MOTOR

MLL/ COST SUMMARY

ASSEMBLY OR SYSTEM

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
Program Executive											
Program Plan. & Rept.											
Industrial Relations											
Engineering											
Laboratory Technicians											
Tooling											
Production			49	476						49	476
Manufacturing Test											
Manufacturing Tech.											
Q&RA			14	139						14	139
Facilities											
Direct Distributable											
Training											
Total Direct Labor			63	\$ 615						63	\$ 615
Material				5,311							5,311
Logistic Hardware											
Burden											
Total Material				\$5,311							\$5,311
Total Other									\$ 176		\$ 176
TOTAL COST				\$5,926					\$ 176		\$6,102
* Based upon input from Aerojet, no further detail was available.											

MLW
SOLID ROCKET MOTOR
(DOLLARS IN THOUSANDS)
1ST UNIT COST

TABLE 5.5.2.0-II

*Motor Costs

1. Chamber		\$1,988
2. Nozzle:		
Shell	\$532	
Ablatives and Exit Cone	914	
Flexible Seal Assembly	263	
Actuators (2/motor)	84	
APU (2/motor)	<u>147</u>	1,940
3. Case Installation		104
4. Propellant and Liner Materials		1,249
5. Igniter		30
6. Shipping		176
7. Manufacturing Labor		
Process and Assembly	\$476	
Inspection	139	<u>615</u>
TOTAL MOTOR COST LESS FEE		<u>\$6,102</u>

* Based on Aerojet input of January 15, 1969.

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5.5.3 Other Stage Components

*OTHER STAGE HARDWARE

ASSEMBLY OR SYSTEM

TABLE 5.5.3.0-I

MLLV COST SUMMARY

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT. END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES											
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR											
MATERIAL				1,629							1,629
LOGISTIC HARDWARE											
BURDEN											
TOTAL MATERIAL				\$1,629							\$1,629
TOTAL OTHER											
TOTAL COST				\$1,629							\$1,629

* Based on Aerojet input (total dollars only).

MLLV
OTHER STAGE HARDWARE

DOLLARS IN THOUSANDS
1ST UNIT COST

TABLE 5.5.3.0-II

OTHER STAGE COST

1. Instrumentation		\$ 464
2. Electrical System		360
3. Stage Separation Components		
Separation Rockets (7 motor) Set	35	
Initiation Components	<u>9</u>	44
4. Destruct Charges Firing Components		21
5. Other Stage Components		
Heat Shield	311	
Raceway (Tunnel)	126	
Environmental Control Ducts	83	
Mounting & Fairings	<u>220</u>	<u>740</u>
TOTAL COST LESS FEE		<u>\$1,629</u>

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5.5.4 SRM Facility Maintenance

*MLLV-FACILITIES MAINTENANCE
1ST UNIT COST

TABLE 5.5.4.0-I

MLLV COST SUMMARY

SRM STRUCTURE

A ☐ B ☐ C ☒

(IN THOUSANDS)

ELEMENT OF COST	PROGRAM MGMT. PART I		CONT: END ITEM PART II		FACILITIES PART III		LOGISTICS PART IV		OTHER	TOTAL	
	M/H	\$	M/H	\$	M/H	\$	M/H	\$		M/H	\$
PROGRAM EXECUTIVE											
PROGRAM PLAN.& REPT.											
INDUSTRIAL RELATIONS											
ENGINEERING											
LAB TECHNICIANS											
TOOLING											
PRODUCTION											
MANUFACTURING TEST											
MANUFACTURING TECH.											
Q & R A											
FACILITIES					11	\$101				11	\$101
DIRECT DIST											
TRAINING											
TOTAL DIRECT LABOR					11	\$101				11	\$101
MATERIAL											
LOGISTIC HARDWARE											
BURDEN											
- TOTAL MATERIAL											
TOTAL OTHER											
TOTAL COST						\$101					\$101

* Allocated per stage for items built at Michoud.

MLLV
RECURRING
SRM

* FACILITIES MAINTENANCE
(DOLLARS IN THOUSANDS)

TABLE 5.5.4.0-II

1. Maintenance of Equipment	\$ 64
2. Maintenance of Brick and Mortar	<u>37</u>
TOTAL	<u>\$101</u>

* Allocated per vehicle. Dollars shown are for structural components built at Michoud.